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Acquiring the Many Meanings of Simple, Negated and Modal Disjunction: Insight from L1 French

Acquérir les Nombreuses Significations de la Disjonction Simple, Négative et Modale : Aperçus du Français L1

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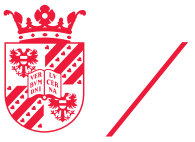
Insights from L1 French

Antoine Cochard



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Chapter 1

Introduction

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1 Introduction

This thesis explores the L1 acquisition and the interpretation of the French disjunctive word *ou* "or". Take (1) as an illustration.

(1) Liz a acheté un croissant ou un donut.
Liz AUX.3SG.PRS buy.PART.PST a croissant or a donut
Liz bought a croissant or a donut.
a. Liz bought a croissant or a donut, but not both.
b. Liz bought a croissant or a donut, but we do not know which.

Disjunctive words are intriguing. From the perspective of classical logic, (1) allows for three scenarios: one in which Liz buys a croissant, one in which Liz buys a donut and one in which she buys both pastries. From the point of view of adult speakers, however, uttering a disjunctive statement in the scenario in which Liz buys both pastries is often taken to be infelicitous. Instead, most French speakers conclude that this sentence means that Liz bought only one pastry, either a croissant or a donut (1a), although it is uncertain which of the two (1b). To account for this discrepancy, it has been proposed that disjunctive words trigger pragmatic enrichment that restricts the logical meaning, eliminating the scenario in which Liz buys both the croissant and the donut from the range of possible situations, since the speaker would have used *and* if they had meant to describe such a situation. This process, which requires the hearer to picture another way the world could be described and then negate this *alternative* scenario, is traditionally referred to as a scalar implicature (Grice, 1975, 1989; Horn, 1972; Gazdar, 1979).

Pragmatic reasoning with disjunction has been shown to be notoriously difficult for children of age four to six, regardless of the language they are learning (Boster & Crain, 1993; Chierchia et al., 2001b, 2001a; Singh et al., 2016; Tieu et al., 2017; Cochard et al., 2023; Sauerland & Yatsushiro, 2018; Pagliarini et al., 2018a; Goro et al., 2006; Huang & Crain, 2020; Su, 2014; Su & Crain, 2010; Bleotu et al., 2023; Braine & Rumain, 1981; Paris, 1973; Lobina et al., 2023a; among many others). For a long time, it was assumed, pessimistically, that children were incapable of producing such elaborate reasoning. The picture is, however, far more complex and subtle than that. With the advent of new methodologies to test interpretation and the development of new theoretical frameworks to characterise the many readings of disjunction, children's hidden pragmatic abilities have been rediscovered. Thus, it is no longer a question of whether children know how to compute such reasoning. Instead, current acquisition research asks rather which parts of the reasoning differ from the adults and how to account for non-adult-like readings with respect to the theoretical improvements in modelling scalar implicatures. At the same time, these theoretical advances have enabled research on adult interpretation of disjunctive statements to further investigate how disjunction is processed in different contexts and to develop a more fine-grained characterization of the resulting interpretations.

This thesis seeks to address these new theoretical and empirical challenges raised by disjunction by bringing together two different perspectives. First, we aim to provide new empirical generalisations on the acquisition of simple, negated and modal disjunction that any theoretical framework should be able to address. In particular, we show that the performance across disjunctive contexts is related and that children display non-adult-like interpretations with modal disjunction. We furthermore probed the adult data which are often considered as secondary, if reported at all, in acquisition studies. In particular, we show that adults' readings are more varied than initially assumed, which had a critical impact on the interpretation of the

acquisition data.

Second, developing the hypothesis that children's responses can be accounted for under a unified approach, we bring a novel argument in support of the grammatical approach to scalar implicatures. In line with the position advocated by Singh et al. (2016), we assume that children have the ability to produce pragmatically enriched meanings, via the insertion of an exhaustification operator in the syntactic structure, but crucially not in the same way as adults. Specifically, in addition to Singh et al.'s (2016) well established explanation that children have difficulties integrating the conjunctive scenario in scalar implicature reasoning, we propose that children can produce enriched meanings at a local level in the syntactic structure, with this reasoning triggered by a preference to resolve ignorance (1b) as early and as much as possible.

2 Puzzle: The many meanings of disjunction

Disjunction does not appear only in simple affirmative sentences. It can also be embedded in a wide range of linguistic environments, each tainting the interpretation of disjunction in their own way. In this section, we briefly introduce each of the disjunctive environments under consideration in this book and the questions they raise for both the theory and acquisition.

2.1 Simple disjunction

A simple disjunctive statement, such as (2), typically receives a basic literal meaning as in (2a) and is strengthened to the *exclusive* meaning in (2c) by negating the stronger, *conjunctive* alternative scenario in (2b).

(2) Liz bought a croissant **or** a donut.
   a. **Basic literal meaning:** Liz bought a croissant or a donut, **possibly both**.
   b. **Conjunctive alternative:** Liz bought a croissant **and** a donut.
   c. **Exclusivity inference:** Liz bought a croissant or a donut, **but not both**.

However, it is well known that not all children engage in such pragmatic reasoning like adults. Instead, the two kinds of non-adult-like responses to simple disjunctive statements attested in the literature correspond to an *inclusive* interpretation (3a; Boster and Crain 1993; Chierchia et al. 2001b, 2001a; Singh et al. 2016; Tieu et al. 2017; Cochard et al. 2023; Sauerland and Yatsushiro 2018; Pagliarini et al. 2018a; Goro et al. 2006; Huang and Crain 2020; Su 2014; Su and Crain 2010; Bleotu et al. 2023) and a *conjunctive* interpretation (3b; Braine and Rumain 1981; Paris 1973; Singh et al. 2016; Tieu et al. 2017; Cochard et al. 2023; Bleotu et al. 2023; Lobina et al. 2023a).

(3) Non adult-like readings of disjunction:
   a. **Inclusive interpretation:** Liz bought a croissant or a donut, possibly both.
   b. **Conjunctive interpretation:** Liz bought a croissant and a donut.

Whereas the *inclusive* interpretation was straightforwardly accounted for as the absence of pragmatic enrichment, the *conjunctive* interpretation posed a theoretical challenge for the traditional view of scalar implicatures. By contrast, employing the grammatical approach to scalar implicatures, Singh et al. (2016) and Tieu et al. (2017) showed that the *conjunctive* reading can be explained under the assumption that children fail to incorporate the *conjunctive* alternative scenario in their reasoning, which has critical consequences for the resulting interpretation, as it leads to a conjunctive pragmatic enrichment. This explanation raised a number of questions that have yet to receive satisfactory answers. Two questions that will be

central in this dissertation are (i) whether performance on simple disjunction can be related to performance in other disjunctive contexts, such as negated disjunction and modal disjunction; and (ii) whether performance on simple disjunction can serve as a diagnostic for distinguishing adult-like from non-adult-like interpretations in other disjunctive contexts.

2.2 Negated disjunction

Consider the negated disjunctive statement in (4), in which the disjunctive word *ou* "or" is embedded under a propositional negation. Depending on the scope configuration between disjunction and negation, three readings are in principle possible. When negation outscopes disjunction, (4) yields the *neither...nor* interpretation in (4a) in which Liz did nothing. Conversely, if disjunction outscopes negation, (4) yields the reading in (4b), traditionally referred to as the *not both* interpretation, in which Liz did not buy one of the two pastries, and possibly neither. Finally, as with simple disjunction, applying pragmatic enrichment when disjunction outscopes negation allows the alternative scenario in which Liz bought neither of them to be negated, giving rise to the *exclusive* interpretation in (4c).

(4) Liz did **not** buy a croissant **or** a donut.

a. **NOT > OR:**
Liz bought neither a croissant nor a donut. Neither...nor

b. **OR > NOT:**
Liz did not buy a croissant or she did not buy a donut, possibly neither. Not both

c. **OR > NOT with exclusivity inference:**
Liz either did not buy a croissant or she did not buy a donut. Exclusive

Negated disjunctive statements have attracted a large amount of interest in the literature. From a typological perspective, Szabolcsi (2002) and numerous subsequent studies have shown that the interpretation of negated disjunction is subject to cross-linguistic variation. In languages such as English, Dutch and Korean (i.e., NEG > OR languages), negated disjunction typically receives a *neither...nor* interpretation, whereas in languages such as Hungarian, Italian and Japanese (i.e., OR > NEG languages), it is interpreted exclusively. In parallel, many acquisition studies have shown that this cross-linguistic division is absent in children of the age of four to five (Crain et al., 2002; Goro & Akiba, 2004; Goro, 2007; Geçkin et al., 2018; Cochard et al., 2023; Jing, 2008; Verbuk, 2006; Lee, 2010). Specifically, it has been found that children overwhelmingly prefer the *neither...nor* interpretation, including children who are acquiring a language where disjunction preferably scopes over negation. To account for this preference, a large number of studies have proposed that this preference arises from children adhering to a developmental principle, the Semantic Subset Principle (Crain, 2008; Crain et al., 1994; Crain, 2012; Moscati & Crain, 2014), which posits that children initially favour the interpretation that is true in the smallest set of circumstances, here, the *neither...nor* reading.

However, these findings have been challenged in recent studies on both adults and children. For a long time, the available adult data appeared to support a strict cross-linguistic division between NEG > OR and OR > NEG languages. Yet, several studies have found that the allegedly unavailable reading in a given language can become accessible when the right conditions are met. For example, French has often been classified as allowing only the *exclusive* reading of negated disjunction (e.g., Nicolae 2017; Spector 2014; Pagliarini et al. 2022). However, when Lungu et al. (2021) developed an acceptability judgment task with a disjunctive statement followed by a brief disambiguating sentence, instead of the traditional truth-value judgment task, they found that French speakers, along with speakers of English, Italian, and Romanian,

rated high continuations that enforced the allegedly unavailable reading in these languages (for French, see also Larralde et al. 2021; Becerra Zita et al. 2014). These findings suggest that there is no clear typological division, if any, and, moreover, cast doubt on the assumption of one clear and consistent adult target, raising critical concerns for acquisition studies. One of the aims of this dissertation is therefore to investigate the issue of the interpretation of negated disjunction in French adults by designing studies that test to what extent speakers have access to all possible interpretations, and how this may be modulated by prosody. As will be shown in Chapters 3 and 4, our findings suggest that within a single language, such as French, two populations with two distinct preferences of interpretation can coexist.

2.3 Modal disjunction

Take (5) in which a disjunctive statement is embedded under a possibility modal, henceforth modal disjunctive statements. Such statements are known to give rise to a form of conjunctive reading in which Liz has the possibility to buy a croissant and she also has the possibility to buy a donut (5b). This interpretation is traditionally referred to as a free choice inference (Kamp, 1974; von Wright, 1968). This inference is often accompanied by a complementary exclusivity inference in (5c), which has been argued to be optional (Simons, 2005).

(5) Liz **can** buy a croissant **or** a donut.
   a. **Basic literal meaning:** Liz can buy a croissant or a donut, **possibly both**.
   b. **Free Choice inference:** Liz can buy a croissant **and** she can buy a donut.
   c. **Exclusivity inference:** Liz **cannot** buy **both** a croissant and a donut.

Modal disjunctive statements have given rise to a flourishing literature focused on the mechanisms underlying the derivation of the free choice inference. Unlike regular scalar implicatures, such as the exclusivity inference in simple disjunctive statements in (2c), the free choice inference is strikingly robust and readily available for both adults (Chemla & Bott, 2014) and children (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020). This raised concerns in semantic theory as to whether the inference should be considered as a genuine scalar implicature (Alonso-Ovalle, 2006; Kratzer & Shimoyama, 2002; Fox, 2007; Chierchia et al., 2011; among others), which is typically associated with a processing cost, or whether it originates as a different kind of phenomenon. In particular, the grammatical approach to scalar implicatures developed by Fox (2007), Chierchia et al. (2011), Chemla (2009b), and Bar-Lev and Fox (2020) was designed to explain how the free choice inference can arise as an implicature, and has since played a central role in characterising a wide range of phenomena involving scalar implicature reasoning, including the acquisition of disjunction.

At first glance, the case seems settled: children behave in an adult-like fashion with free choice inference, and this can be explained within the exhaustification framework. However, this apparent completeness masks unresolved puzzles. First, it is striking that children, who typically struggle with both disjunction and modals separately (for modals, see Noveck 2001; Ozturk and Papafragou 2015; Dieuleveut and Noveck 2025; among many others), show adult-like behaviour in an environment that combines both elements. As demonstrated in Chapter 5, our thesis argues that previous experimental designs did not test modal disjunctive statements with sufficient precision, without the critical conditions that are essential to diagnose the free choice inference with confidence. Chapter 5 addresses this challenge by developing a new experimental setup based on Liu (2019), including new conditions that specifically target an alternative, non-adult-like interpretation of children's responses in modal disjunctive statement, namely, modal conjunction. As will be shown, a subset of children exhibited this

Modal Conjunctive interpretation, a novel empirical generalisation that has also been observed in Romanian children by Bleotu et al. (2024b), who adapted one of our critical conditions and obtained comparable results.

Second, the question of the exclusivity inference in modal disjunctive statements has been largely neglected. While Simons (2005) characterised this inference as optional, empirical evidence supporting this claim is scarce for adults (see however Liu 2019), and entirely absent for children. This gap in the literature is concerning for acquisition. Since, children are known to struggle at deriving the exclusivity inference in simple disjunctive statements, it makes it reasonable to expect that they face similar difficulties in modal disjunctive statements. However, it has never been investigated whether children derive both the free choice and the exclusivity inferences together. Chapter 5 seeks to provide novel adult data to assess whether the exclusivity inference is truly optional.

3 Roadmap

This dissertation consists of six chapters, including the present introduction. It is organised as follows.

Chapter 2 introduces the theoretical framework that will be employed in this dissertation. In this chapter, we briefly review the vast literature on scalar implicatures, focusing especially on disjunction and how to derive its many meanings. After presenting some general assumptions about disjunction, including its basic meaning, its interpretations and alternatives, we present two frameworks that have accounted for its inferences: the traditional (Neo-)Gricean approach (Grice, 1975, 1989; Gazdar, 1979) and the grammatical approach to scalar implicatures (Kratzer & Shimoyama, 2002; Fox, 2007; Chierchia et al., 2011). In particular, we detail how the exclusivity (1a) and ignorance (1b) inferences arise, and discuss some specific cases where disjunction appears to receive the truth conditions of conjunction. Finally, we introduce some of the challenges for testing disjunctive statements and motivate why we adopted the grammatical approach to scalar implicatures to account for children's non-adult-like interpretations.

Chapter 3 presents our first study on the acquisition of disjunction comparing simple and negated environments in French. This study was specifically designed to examine these two contexts in parallel in order to determine whether the interpretation patterns observed in affirmative contexts are related to those in negated contexts, thereby shedding light on the pragmatic mechanisms underlying children's development of disjunction. The study was carried out with 96 four to eight year-old French-speaking children recruited at their school and 83 French-speaking adults recruited online. Adapting the reward system from Goro and Akiba (2004) and addressing methodological issues identified in previous studies (Skordos et al., 2020; Tieu et al., 2017), we designed a truth-value judgment task that specifically aimed to test simple and negated disjunctive statements using the same procedure .

Chapter 4[1] addresses the adult interpretation of negated disjunction, asking whether one interpretation can be primed over the other through the means of prosody. The rationale for the two studies in Chapter 4 builds on the results of Chapter 3 as well as on a series of recent studies on French (Larralde et al., 2021; Lungu et al., 2021; Becerra Zita et al., 2014). We raise the question whether the alleged unavailable reading of negated disjunction in French (the *neither...nor* interpretation) results from a genuine dispreference for it or from a disambiguating factor that has not been controlled before, that is, prosody. In the literature on the prosody-semantics interface (Bolinger, 1965; Jackendoff, 1972; Pruitt & Roelofsen,

[1] The experiments reported in Chapter 4 are part of a broader project which seeks to examine the role of prosody in the interpretation of negated disjunction (PIs: Angeliek van Hout and Balázs Surányi).

2013; Syrett et al., 2014), prosody has been shown to be a decisive factor in resolving the scope configuration of two interacting operators. To address this question, we first determined whether a specific interpretation would be associated with a particular prosodic contour. To this aim, an experiment was carried out with 40 native-French speakers, using a prosody-selection task using van Hout et al.'s (2024) methodology and adapting Surányi and Gulás's (2022) prosodic contours to French. We then conducted a second study using a truth-value judgment task, in which two groups of 40 adults each evaluated negated disjunctive statements produced with distinct prosodic contours, with each group exposed to a different contour.

Chapter 5 returns to acquisition and examines the interpretation of modal disjunctive statements. The purpose of this study was to challenge findings that children interpreted such statements in an adult-like manner, readily deriving the free choice inference (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020). Building on the conjecture from Chapter 3 that children give non-adult-like conjunctive interpretations of disjunction across contexts, we hypothesised that children might assign a *Modal Conjunctive* interpretation to modal disjunctive statements. First, we show how the free choice and the modal conjunctive interpretations are different from each other. Even though they yield the same outcome for several scenarios, they crucially diverge on one type of scenario: *Mutually Exclusive* contexts. We then argue that previous studies could not distinguish between a free choice interpretation and a *Modal Conjunctive* one, and thus left open the possibility that some children may have been prematurely categorised as adult-like. Moreover, previous work overlooked another aspect of the adult-like interpretation of modal disjunctive statement: the additional exclusivity inference that is predicted to systematically arise under the exhaustification framework. To address these problems, we designed a novel setup, adapting the lottery machine paradigm from Liu (2019), that specifically aimed to differentiate the free choice interpretation and the *Modal Conjunctive* interpretation as well as detecting whether the additional exclusivity inference was derived. To this end, our design included a *Mutually Exclusive* condition, as well as a new condition specifically designed to test for the exclusivity inference: the *Package* condition. The experiment was carried out with 68 French-speaking four-to-six year-old children recruited at school and 40 French-speaking adults recruited online.

Chapter 6 summarises and discusses the main findings of the three previous chapters. It also sketches a possible developmental trajectory, outlines future directions for testing disjunction, and explores a recent alternative to the grammatical approach to scalar implicatures as a way of accounting for our results.

4 How to read this book

This book is structured into six chapters, including the present introductory one. Each chapter is designed to be read independently, with the exception of Chapter 6, which builds on the findings presented in Chapters 3, 4, and 5.

Chapter 2 offers a modest theoretical review of the vast literature on the derivation of the many inferences of disjunction. While this chapter is not essential for understanding the remainder of the book, it is particularly recommended for the reader unfamiliar with scalar implicatures reasoning and, especially, with the corresponding grammatical account. For such readers, Chapter 2 provides some relevant background to better grasp the theoretical assumptions and analyses developed in the subsequent chapters.

Chapters 3, 4, and 5 are written in the form of stand-alone research articles. Consequently, relevant theoretical material from Chapter 2 is recapitulated within each of these chapters so that they can be read independently. The resulting redundancy is therefore intentional. Certain

aspects of the analysis are also repeated across chapters. For example, the clustering-based method employed in the three experimental chapters is still relatively novel in the field of language acquisition. By presenting the method in full in each chapter, we aim to contribute to the growing methodological toolbox of the field and to support future research efforts that may adopt similar approaches. Finally, all data, R scripts, and stimuli are available online at the following page: github.com/acochard/dissertation

Chapter 2

Formal background

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The goal of this dissertation is twofold: First, it examines the acquisition of disjunctive statements in different linguistic environments such as matrix sentences, under negation, and under modals. Second, it provides a formal account of children's performance with disjunction. In this respect, the present chapter is crucial: it introduces the general background on disjunction and scalar implicatures and outlines the core components of the formal framework adopted in Chapters 3 and 4, namely, the grammatical approach to scalar implicatures. Crucially, as will be reaffirmed throughout this chapter, the empirical generalisations about children's performance in each of the aforementioned disjunctive environments hold independently of the formalism introduced here.

The chapter is organised as follows. Section 1 introduces the general assumptions about disjunction that will be maintained throughout the book. Section 2 reviews the pragmatic inferences traditionally associated with disjunction. Section 3 details the core functioning parts of the grammatical approach to scalar implicatures. Finally, Section 4 discusses key challenges in testing disjunction, which will be addressed in each of the studies presented in this book.

1 General assumptions: The meanings of disjunction

In this section, we briefly review the range of interpretations available for disjunctive statements and outline the assumptions we adopt for the rest of this book. Section 1.1 shows that disjunction has a literal inclusive meaning. Section 1.2 introduces the inferences arising from disjunctive statements. Finally, Section 1.3 rules out the possibility that disjunction is ambiguous between an inclusive and an exclusive literal meaning.

1.1 The basic meaning of disjunctive statements: Logical disjunction

Consider the disjunctive statement in (1) and the three possible scenarios in (2).

(1) Liz bought a croissant or a donut.

(2) a. Liz bought a croissant.
b. Liz bought a donut.
c. Liz bought a croissant and a donut.

Under classical logic, (1) is compatible with three scenarios: Liz bought a croissant (2a), Liz bought a donut (2b), and Liz bought both the croissant and the donut (2c). That is, *P or Q*[1] is taken to be true if at least one of the two disjuncts holds. This interpretation is referred to as the inclusive interpretation of disjunction (noted $\vee$). The corresponding truth table is given in Table 1.

P	Q	$(P \vee Q)$
1	1	1
1	0	1
0	1	1
0	0	0

Table 1: Truth table for logical disjunction ($\vee$). By convention: 1 is true, 0 is false.

[1] P and Q have to be understood as separate, non identical, propositions. We will not cover specific uses of disjunction of the form (P or not P), as in "Did you eat the cake or did you not [eat the cake]?".

From now on and until the end of this book, unless mentioned otherwise, it will be assumed that disjunctive words, such as English *or* or French *ou*, receive the basic lexical denotation in (S1:3), which corresponds to logical inclusive disjunction. The formula can be paraphrased as follows: ⟦or⟧ takes two propositional arguments and returns true if at least one of the two disjuncts is true.

(3) $\llbracket \text{or} \rrbracket = \lambda u \in D_{<t>}.\lambda v \in D_{<t>}.u \vee v = 1$

Accordingly, any other reading that the reader might infer from a disjunctive statement is assumed to arise secondarily, as the consequence of a pragmatic reasoning. Importantly, although adults' intuitions often lean toward the interpretation that exactly one disjunct is true, henceforth the exclusive interpretation, the inclusive interpretation surfaces transparently when disjunction is uttered in environments where pragmatic reasoning is generally neutralised, such as downward entailing contexts.[2] To illustrate, take the example in (4), in which a disjunctive statement has been embedded in one such context, namely, the antecedent of a conditional statement. Intuitively, (4) allows for three possible outcomes in which Liz's brother is happy: Liz bought a croissant and a donut (4a), Liz bought a croissant but not a donut (4b), and Liz bought a donut but not a croissant (4c).

(4) If Liz buys a croissant or a donut, her brother will be happy.
   a. ✓ Liz bought both a croissant and a donut, therefore her brother is happy.
   b. ✓ Liz bought a croissant, therefore her brother is happy.
   c. ✓ Liz bought a donut, therefore her brother is happy.
   d. × Liz bought neither a croissant nor a donut, therefore her brother is happy.

If disjunction had initially received a non-inclusive denotation, the set of acceptable outcomes for (4) would have been different. For instance, if disjunction in (4) were interpreted exclusively, meaning that Liz only bought one of the two pastries but not both, as illustrated in (5), this would indicate that it is not inherently inclusive. This, however, is not the case. Moreover, evidence presented in Section 3 demonstrates that disjunction cannot be assigned a basic exclusive interpretation.

(5)
   a. × Liz bought both a croissant and a donut, therefore her brother is happy.
   b. ✓ Liz bought a croissant, therefore her brother is happy.
   c. ✓ Liz bought a donut, therefore her brother is happy.
   d. × Liz bought neither a croissant nor a donut, therefore her brother is happy.

Importantly, some children interpret disjunction as if it had the truth conditions of a conjunction. Nevertheless, even in such cases, we maintain that disjunction is fundamentally inclusive in meaning and does not receive a basic conjunctive denotation. Demonstrating the inherently inclusive nature of disjunction is essential to establish that its semantics cannot be freely adjusted to match the interpretations inferred by speakers. In particular, we rule out the possibility that children simply assign the lexical entry of conjunction to disjunction, namely, that children confuse both connectives. Rather, as it will be shown in Section 3.3 and further demonstrated in Chapters 3 and 5, we argue that conjunctive interpretations of disjunction systematically arise as a consequence of a specific pragmatic reasoning.

[2] A function f is downward-entailing iff for every P, Q such that $P \subseteq Q$, $f(P) \Rightarrow f(Q)$. Downward-entailing contexts licence inferences from supersets to subsets but not conversely. For instance, negation is downward entailing because "Liz didn't buy pastries" entails "Liz didn't buy a croissant.", but the reverse is not true.

1.2 Outlook: The inferences of simple disjunction

Disjunctive statements typically carry two inferences: an ignorance inference (6a), and an exclusivity inference (6b). Both inferences originate from the interplay between the literal inclusive meaning of disjunction and pragmatic reasoning. These inferences have been traditionally referred to as conversational implicatures.

(6) Liz bought a croissant or a donut.
   a. Liz bought a croissant or a donut, but we do not know which. Ignorance
   b. Liz bought a croissant or a donut, but not both. Exclusivity

Each inference operates at a different level. Ignorance inferences primarily deal with the belief states of the speaker. For instance, it is natural to conclude from (6) that the inferences in (7a) and (7b) hold. Notice that (7c) logically follows from the two others. Here, the speaker is unsure whether Liz bought a croissant (7a), a donut (7b), or both (7c).

(7) a. It is not the case that the speaker believes that Liz bought a croissant.
   b. It is not the case that the speaker believes that Liz bought a donut.
   c. It is not the case that the speaker believes that Liz bought a croissant and a donut.

Ignorance is a key property of the interpretation of disjunctive statements. In some languages, ignorance is even explicitly encoded and is the driving factor behind the disjunctive interpretation. To illustrate, take Maricopa and Warlpiri, two languages where disjunction is encoded by ignorance markers (bolded). Compare the two sentences in (8) and (9) in Maricopa (Gil, 1991). Maricopa lacks explicit coordinators to express disjunctive and conjunctive interpretations. Instead, both operands are juxtaposed and the disjunctive interpretation is expressed by an uncertainty suffix on the verb, (8), that is, a marker of ignorance. When this suffix is absent as in (9), the sentence receives a conjunctive interpretation, that is, only both disjuncts are true.

(8) John-š Bill-š v?aawuum-***šaa***. Maricopa
   John-NOM Bill-NOM 3-come=PLR-FUT-INFER.UNCERTAINTY
   Lit. "John Bill will come."
   a. ✓ John or Bill will come. Disjunctive interpretation
   b. × John and Bill will come. Conjunctive interpretation

(9) John-š Bill-š v?aawuum. Maricopa
   John-NOM Bill-NOM 3-come=PLR-FUT-INFER
   Lit. "John Bill will come."
   a. × John or Bill will come. Disjunctive interpretation
   b. ✓ John and Bill will come. Conjunctive interpretation

Now, consider in (10) the case of Warlpiri (Bowler, 2014).[3] Warlpiri follows the same track as Maricopa by encoding ignorance with a periphrastic epistemic construction "Gloria *maybe*, Cecilia *maybe*". The speaker states that she is unsure about the truth of the first disjunct and that she is unsure about the truth of the second disjunct.[4] In Section 2.1, we further detail how

[3] The story is, in fact, more intricate for Warlpiri. Bowler (2014) argues that Warlpiri does have an explicit disjunctive coordinator *manu* "or" that is interpreted like a conjunction in unembedded environments and as an inclusive disjunction in downward-entailing contexts. This specific case is discussed later in Section 3.3.2.

[4] This periphrastic construction is reminiscent of Zimmermann's (2000) analysis of disjunction. For Zimmerman,

ignorance is generated in languages that do not encode it explicitly, but rather derive it through pragmatic reasoning.

(10) Gloria *marda*, Cecilia *marda* yanu tawunu-kurra=ju. Warlpiri
Gloria maybe Cecilia maybe go.PST town.ALL=TOP
Lit. "Gloria maybe, Cecilia maybe went to town."
"Gloria or Cecilia went to town."

Let us now turn to the exclusivity inference. This inference restricts the range of possible outcomes licensed by an inclusive disjunction by ruling out the scenario in which both disjuncts are true, as illustrated in (11).

(11) Liz bought a croissant or a donut, but not both. $(P \vee Q) \wedge \neg(P \wedge Q)$
a. Liz bought a croissant. P
b. Liz bought a donut. Q
c. ~~Liz bought a croissant and a donut.~~ $\neg(P \wedge Q)$

By negating the conjunctive possibility in (11c), the sentence yields a stronger interpretation than inclusive disjunction, because it is true in a smaller number of situations. This results in an exclusive reading of disjunction, where exactly one of the two disjuncts is true: Liz bought a croissant or a donut, but it is not the case that she bought both a croissant and a donut. The corresponding truth table is given in Table 2.

P	Q	$(P \oplus Q)$
1	1	0
1	0	1
0	1	1
0	0	0

Table 2: Truth table for exclusive disjunction ($\oplus$). By convention: 1 is true, 0 is false.

Sections 2.2 and Section 3 will examine more closely how the exclusivity inference is derived, either as the result of a conversational implicature or through the application of an operator whose function is to exclude as many possible outcomes as possible, that we will refer to hereafter as alternatives.

1.3 Disjunction is not basically exclusive

Disjunction is not semantically ambiguous between the inclusive denotation in (3) and an exclusive denotation such as (12), $[\![or^{\text{EXCL}}]\!]$, which would return true only if exactly one of the two disjuncts is true. Instead, we assume that the exclusive reading of disjunction arises through pragmatic reasoning rather than from a distinct lexical item with the same phonological form as inclusive disjunction.

(12) $[\![\text{or}^{\text{EXCL}}]\!] = \lambda u \in D_{<t>}.\lambda v \in D_{<t>}.u \oplus v = 1$

The exclusive interpretation must be viewed as an inference rather than built into the

disjunction is not inherently inclusive but is rather the conjunction of epistemic possibilities. That is, there's a world (accessible/epistemically possible) in which the first disjunct holds, and there's (possibly a different) world in which the second disjunct holds.

semantics of a lexical item. A hallmark of pragmatically inferred meanings is that they are (generally) optional and readily defeasible. To illustrate this point, consider (13) from Spector (2014).

(13) a. Marie ira au cinéma lundi ou mardi.
Mary go.3SG.FUT at.the cinema Monday or Tuesday
"Mary will go to the cinema on Monday or on Tuesday."

b. Absolument ! Et elle ira même à la fois lundi et mardi.
absolutely! and she go.3SG.FUT even at the time Monday and Tuesday
"Absolutely! And she will even go on both Monday and Tuesday."

Most French speakers would judge (13b) as a valid continuation to the disjunctive statement in (13a). However, if French *ou* "or" had received an exclusive denotation, then (13b) would have been judged as contradictory. The reason is that the exclusive interpretation rules out the conjunctive scenario, which is incompatible with the continuation in (13b) that explicitly affirms it. Here, the pragmatic reasoning leading to the exclusive interpretation of (13a) must have been cancelled. To illustrate further that disjunction does not have a literal exclusive meaning, let us turn briefly to other constructions involving disjunctive statements: complex disjunction and negated disjunction.

Complex disjunctive constructions are statements that contain more than one disjunctive word and express a strong exclusive interpretation. Consider (14) from Spector (2014) as a counterpart to (13) which features French's complex disjunction *soit...soit...* "either...or...".

(14) a. Marie ira au cinéma soit lundi soit mardi.
Mary go.3SG.FUT at.the cinema SOIT Monday SOIT Tuesday
"Mary will go to the cinema on Monday or on Tuesday."

b.#Absolument ! Et elle ira même à la fois lundi et mardi.
absolutely! and she go.3SG.FUT even at the time Monday and Tuesday
"Absolutely! And she will even go on both Monday and Tuesday."

The sentence in (14a) only differs from (13a) by the complexity of its disjunctive statement. Whereas (13b) is taken to be a felicitous continuation to (13a), the exact same reply to (14a), (14b), sounds particularly odd. This is because the added information that Mary will go to the cinema on both Monday and Tuesday directly contradicts the exclusive interpretation that is derived beforehand. Note, importantly, that even the exclusive interpretation in complex disjunction is defeasible, though less easily than for the regular disjunctive statement. For instance, Spector (2014) reports that (15b) is a successful continuation to (15a), in which exclusivity has been cancelled.

(15) a. Tous mes étudiants étudient soit l'allemand soit l'anglais.
All my students study.3PL.PRS soit the.german soit the.english
"Every student of mine studies either German or English."

b. Absolument ! Et certains étudient même les deux.
Absolutely! and some study.3PL.PRS even the two
"Absolutely! And they even study both."

Notice that in the case of multiple disjunctions (i.e. utterances that contain two or more

disjunctive connectives), it has long been pointed out that the exclusive disjunction does not generalise in the way natural language suggests (Reichenbach 1947; see also Simons 2001). To illustrate, while $(P \oplus Q \oplus R)$ is true when an odd number of disjuncts are true, hence also when all three are true, this would contradict the "exactly one" intuition for sentences such as *My students study German or English or French* (i.e. only one language).

Let us turn now to negated disjunction. Negated disjunctive statements are disjunctive statements embedded under a negation, such as in (16). For more details about negated disjunction, see Chapters 3 and 4.

(16) Liz won't go to the library or do the groceries today.

If disjunction had received an exclusive denotation, negated disjunctive statements would give rise to an interpretation that is never attested. By the logical equivalence in (17a),[5] the English negated disjunctive sentence in (16) is typically interpreted as Liz neither going to the library nor doing the groceries, that is Liz stayed home instead.[6] If disjunction had received an exclusive denotation, then (16) would have been ambiguous between two situations, (17b): either Liz stayed home and did nothing, or she went to both the library and did the groceries altogether. However, this interpretation is, to date, not available in empirical studies investigating negated disjunction.[7]

(17) a. $\neg(P \vee Q) \Leftrightarrow \neg P \wedge \neg Q$
b. $\neg(P \oplus Q) \Leftrightarrow (P \leftrightarrow Q)$

To summarize, we made three assumptions. First, we assumed that disjunctive statements have a basic semantic denotation corresponding to the one of a logical inclusive disjunction. Second, disjunction yields at least two inferences: an ignorance inference according to which the speaker is unsure about which disjunct is true, and an exclusivity inference that states that exactly one disjunct is true. Third and finally, we discarded the possibility for disjunction to be ambiguous between two semantic denotations. In particular, we showed that an exclusive denotation for disjunction must be ruled out. Each of these three assumptions will be maintained for the rest of this book.[8]

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[5] This logical equivalence is one of De Morgan's laws of propositional logic. The second law is $\neg(P \wedge Q) \Leftrightarrow \neg P \vee \neg Q$.

[6] Native language is important here. As further developed in Chapters 3 and 4, languages vary with respect to the scope configuration between disjunction and negation. In languages where disjunction scopes over negation, such as Italian or Hungarian, an exclusive interpretation is expected to arise (i.e., exactly one disjunct is true), whereas for languages where disjunction scopes below negation, such as English or Korean, a *neither...nor* (i.e., no disjunct is true) interpretation is expected.

[7] But see Chapter 3 for the theoretical possibility that this interpretation might be available in children.

[8] Simple disjunctive statements can carry two additional inferences: indifference (ia), and exhaustivity (ib). However, notice that these inferences will not be discussed in this book.

(i) a. Sweets like candies or lollipops will be sold out in a minute. Indifference
b. Liz bought a croissant or a donut (and nothing else). Exhaustivity

An indifference inference arises when the truth of the disjuncts does not matter for the purpose of the conversation. It does not matter if it is candies, lollipops or any other sweets that have similar properties: what matters is that it has to be sold out in a minute (for further discussion about this inference, see Jasbi, 2018). The exhaustivity inference (van Rooij & Schulz, 2004; Spector, 2006) is a type of ad-hoc implicature that negates every other contextual alternative already present in the context (or introduced during the process of excluding alternatives) in order to generate a stronger meaning (for evidence that children know how to derive ad-hoc implicatures at adult rates see Stiller et al., 2014).

2 Interpreting disjunction: A pragmatic reasoning

As introduced in Section 1, a disjunctive statement of the form P or Q such as (18) carries a literal inclusive meaning (18a) and typically gives rise to two inferences: an ignorance inference (18b), and an exclusivity inference (18c). This section explains the pragmatic reasoning responsible for these inferences.

(18) Liz bought a croissant or a donut.
   a. **Literal inclusive meaning:**
      Liz bought a croissant or a donut, possibly both. $(P \vee Q)$
   b. **Ignorance inference:**
      The speaker does not know which of the two pastries has been bought.
   c. **Exclusivity inference:**
      $\rightsquigarrow$ Liz bought a croissant or a donut, but not both. $(P \vee Q) \wedge \neg(P \wedge Q)$

The inferences in (18b) and (18c) have traditionally been classified as conversational implicatures, a specific type of pragmatic reasoning that arises under the assumption that both speaker and hearer act cooperatively. Grice (1975, 1989) models this cooperative behavior through the principle in (19), along with a set of associated maxims, two of which will be introduced in Section 2.2.

(19) **Cooperative Principle**
Make your contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged.
(Grice, 1975; p. 45)

Section 2.1 first introduces the notion of alternatives, possible scenarios participants of the conversation reason with to infer different meanings. In particular, this section discusses scales, a crucial component of the pragmatic reasoning leading to the exclusivity inference and a key aspect of children's non-adult-like performance with disjunction. Then, Section 2.2 explains how ignorance inferences arise by reasoning on the system of beliefs of the speaker[9] (i.e., the doxastic state). Section 2.3 provides the reasoning leading to the exclusivity inference. Finally, Section 2.4 presents a new disjunctive environment, modal disjunction, and its associated free choice interpretation, which poses a significant challenge for the Gricean approach to scalar implicatures presented in this section.

2.1 The notion of alternative

Before diving into the inner workings of the pragmatic reasoning responsible for the interpretation of disjunction, some terminology must be introduced. The set of possible scenarios introduced by disjunction is referred to as the set of alternatives to disjunction, following the standard terminology. More precisely, the set of alternatives for a sentence S, abbreviated as $ALT(S)$, was originally defined as the set of sentences obtained by lexical replacement of an item with members of its Horn scale. Horn scales are sets of lexical items whose members are ordered by entailment relationships (Horn, 1972, 1989). Members of such sets are traditionally referred to as scalar items, as illustrated in (20).

[9] I am highly indebted to Rineke Verbrugge who urged me to clarify the accidental conflation between "speaker's knowledge" and "speaker's belief" in an earlier version of this dissertation. Whenever formulas are given, I use belief-talk. Any remaining uses of *know* or *doesn't know* in the running prose are informal paraphrases for readability and should not be understood as commitments to a factive knowledge operator.

(20) a. < or, and >
b. < some, all >
c. < possible, certain >
d. < one, two, three, ... >

Scalar items whose truth-conditions are a subset of the truth-conditions of their scalar-mate are referred to as stronger or more informative alternatives. For instance, within the scale < *or*, *and* >, disjunction (*or*) is true when at least one of the two disjuncts holds, whereas conjunction (*and*) is true only when both disjuncts hold. Thus, the truth-conditions of conjunction form a subset of those of disjunction, making conjunction the most informative alternative to disjunction. Conversational implicatures, which rely on such lexical scales, are known as scalar implicatures, of which the exclusivity inference is a canonical example.

The set of alternatives of a sentence S can be further enriched by subdomain alternatives, that is, alternatives that correspond to subsets (i.e. a subdomain) of the set under discussion (Rooth, 1985; Sauerland, 2004). Consider (21) as an illustration. Suppose the domain of alternatives is the set of possible pastries Liz might have bought, consisting of a croissant and a donut. The subdomain alternatives are propositions that restrict this domain to individual subsets, namely, the individual disjuncts in (21a) and (21b). Note that, if the contextual domain were larger (e.g. the bakery also sells chocolate eclairs), additional subdomain alternatives would arise (e.g. Liz bought a chocolate eclair).

(21) Liz bought a croissant or a donut.
a. Liz bought a croissant.
b. Liz bought a donut.

Consequently, the set of alternatives to the disjunctive statement in (22) is composed of the two individual disjunct alternatives, and the conjunctive alternative.[10] Note, importantly, that we provide in Section 3.1 a more formal algorithm that generates alternatives by systematic syntactic operations (Katzir, 2007; Fox & Katzir, 2011).

(22) a. ALT(Liz bought a croissant or a donut) = {Liz bought a croissant,
Liz bought a donut,
Liz bought a croissant and a donut}
b. $ALT(P \vee Q) = \{P, Q, P \wedge Q\}$

A substantial body of acquisition studies highlights the critical role of alternatives in explaining children's non-adult-like performance with scalar implicatures. As remarked by Grigoroglou and Papafragou (2017), for a long period of time, it was assumed that children lacked any form of pragmatic sophistication. However, more recent methodologies and refined models of pragmatic reasoning have traced children's difficulties to limitations in the representation and manipulation of alternatives. For instance, Foppolo and Guasti (2005) argue that the lexicalisation of scales is a multi-step developmental process: children first acquire lexical scalar items and only later learn to order them along a scale, with different scales emerging at different developmental stages. Barner et al. (2011) and Barner and Bachrach (2010) further claim that children know how to pragmatically reason but fail to generate and to

[10] Importantly, the prejacent (i.e., the literal meaning) is absent from the set of alternatives in (22). This absence follows from the Gricean framework, which primarily focuses on stronger alternatives and does not require the prejacent to derive enriched meanings. However, as will be shown in Section 3.1, the grammatical approach to scalar implicatures crucially requires the inclusion of the prejacent for technical reasons.

handle alternatives in an adult-like manner. Heredia Murillo (2023) further demonstrates that some Spanish-speaking children even reverse the order of the members of the scale in scalar focus particles such as *even*.

In the case of disjunction, Singh et al. (2016) and Tieu et al. (2017) argue that children have difficulties performing lexical replacement of the disjunctive word by its scalar-mate effectively excluding the conjunctive alternative from pragmatic reasoning. Others, such as Skordos and Papafragou (2016) and Skordos et al. (2020), have proposed that children may generate the conjunctive alternative but consider it irrelevant for the goal of the conversation.

Overall, the notion of alternative is crucial for understanding the acquisition of scalar implicatures, as children's interpretation of disjunction heavily depends on how, and which, alternatives they are able to generate and evaluate. In this respect, Section 3.3.3 will present Singh et al.'s (2016) account of non-adult-like conjunctive interpretations of simple disjunction.

2.2 Ignorance inferences

This section examines how ignorance inferences arise as a form of pragmatic reasoning. The focus on these inferences is motivated by two main considerations. First, as will be shown in subsequent sections, ignorance inferences are a necessary prerequisite for both the exclusivity inference and the non-adult-like conjunctive interpretation to emerge. Second, the formal account developed in Chapter 5 builds on the hypothesis that children tend to eliminate ignorance as much as possible and as early as possible, which crucially determines their non-adult-like interpretation.

Ignorance inferences, also designated as primary or weak implicatures, arise straightforwardly through reasoning about the speaker's doxastic states, that is, the set of beliefs held by the speaker. Upon hearing a disjunctive statement such as (18), the ignorance inferences in (23) are typically generated, one for each possible scenario compatible with inclusive disjunction. These inferences state that the speaker is open to the possibility that Liz did or did not buy a croissant (23a; $\neg\Box_s[P]$), to the possibility that Liz did or did not buy a donut (23b; $\neg\Box_s[Q]$), and to the possibility that Liz did or did not buy a croissant and a donut (23c; $\neg\Box_s[P \wedge Q]$), the latter following from (23a) and (23b). All in all, the speaker is entirely uncertain about what Liz did and did not buy. Notice the subscript s on the necessity modal operator $\Box$, which indicates that the statement is about the speaker's belief states.

(23) Ignorance inferences for (18):
   a. $\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a croissant. $\neg\Box_s(P)$
   b. $\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a donut. $\neg\Box_s(Q)$
   c. $\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a croissant and a donut. $\neg\Box_s(P \wedge Q)$

It is important to emphasize that the ignorance inference in (23c) should not be mistaken for the exclusivity inference. While the exclusivity inference entails that the speaker believes that Liz did not buy both a croissant and a donut (24a), the corresponding ignorance inference only signals that the speaker is uncertain whether she did (24b). As will be demonstrated in the next section, the ignorance inference about the conjunctive scenario will play a crucial role in the derivation of the exclusivity inference.

(24) a. Exclusivity inference: $\Box_s\neg(P \wedge Q)$
   b. Ignorance about $(P \wedge Q)$: $\neg\Box_s(P \wedge Q)$

To derive the ignorance inferences in (23), the first step is to identify the speaker's beliefs.

According to the Maxim of Quality (Grice, 1975), given below in (25), if a speaker chooses to utter a sentence S, then it is reasonable to assume that the speaker believes S to be true.

(25) **Maxim of Quality:** *Try to make your contribution one that is true.*
   a. *Do not say what you believe to be false.*
   b. *Do not say that for which you lack adequate evidence.*

In this case, since the speaker uttered the disjunctive statement Liz bought a croissant or a donut, it can be concluded that the speaker must believe her utterance to be true. This belief is also referred to as the speaker's primary belief, (26).

(26) **Speaker's primary belief (from the Maxim of Quality):**
The speaker believes that Liz bought a croissant or a donut. $\Box_s(P \vee Q)$

The ignorance inferences then arise naturally via the application of the Maxim of Quantity, stated in (27). The complete reasoning is as follows: first, the speaker uttered a sentence S and the hearer inferred that the speaker believes S to be true (from the Maxim of Quality). Then, the Maxim of Quantity applies. If the speaker had believed that a more informative alternative was true, she would have said so. Because she did not, the hearer can infer that the speaker does not believe this stronger alternative.

(27) **Maxim of Quantity:**
   a. *Make your contribution as informative as is required for the current purposes of the exchange.*
   b. *Do not make your contribution more informative than is required.*

Let us now apply this reasoning to disjunction. The speaker chose to utter the disjunctive statement in (18) and did not commit to utter a more informative alternative such as an individual disjunct (*Liz bought a croissant* / *Liz bought a donut*) or the conjunction (*Liz bought a croissant and a donut*). Therefore, the hearer can infer (from the Maxims of Quality and Quantity) that the speaker believes that Liz bought a croissant or a donut ($\Box_s[P \vee Q]$), that it is not the case that the speaker believes that Liz bought a croissant ($\neg\Box_s[P]$), that it is not the case that the speaker believes that Liz bought a donut ($\neg\Box_s[Q]$), and that it is not the case that the speaker believes that Liz bought a croissant and donut ($\neg\Box_s[P \wedge Q]$), resulting in the set of inferences in (23a-c).

2.3 Exclusivity inference

Let us turn now to the exclusivity inference. In the previous section, after calculating the ignorance inferences, the hearer was left with the conclusion that the speaker is ignorant about everything except that Liz bought something, as illustrated in (28).

(28) **Status of the speaker's beliefs after calculating ignorance inferences:**
   a. The speaker believes that Liz bought a croissant or a donut. $\Box_s(P \vee Q)$
   b. $\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a croissant. $\neg\Box_s(P)$
   c. $\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a donut. $\neg\Box_s(Q)$
   d. $\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a croissant and a donut. $\neg\Box_s(P \wedge Q)$

However, this set of beliefs presents a problem. The inference that the speaker is open to the possibility that Liz did not buy both a croissant and a donut (i.e., ignorance about

$\neg\Box_s[P \wedge Q]$) is significantly weaker than the exclusivity inference we aim to capture, namely, that the speaker is certain that Liz did not buy both a croissant and a donut (29; $\Box_s\neg[P \wedge Q]$). The difference between the two inferences lies in the scope of the modal and the negation: in the ignorance inference, the necessity modal takes scope over negation, whereas in the exclusivity inference, the negation scopes over the modal, reversing their order.

(29) **Desired exclusivity inference for (18):**
$\rightsquigarrow$ The speaker believes that it is not the case that Liz bought a croissant and a donut.
$\Box_s\neg(P \wedge Q)$

To resolve this issue, it is necessary to assume that the speaker is epistemically committed (Grice, 1975). That is, the speaker must be capable of holding stronger beliefs than mere ignorance. In particular, she must be able to form an opinion about the truth of stronger alternatives (Fox, 2007; Geurts, 2005; Kratzer & Shimoyama, 2002; Sauerland, 2004; among others). The concept of an opinionated speaker is defined below in (30).

(30) **Opinionated speaker** Fox (2007, p. 18)
When a speaker utters a sentence, S, the addressee assumes, for every sentence $S' \in ALT(S)$, that the speaker's beliefs determine the truth value of S', unless this assumption would lead to the conclusion that the speaker's beliefs are contradictory.

The concept is paraphrased as follows: a speaker is said to be opinionated about a stronger sentence S' if and only if she believes that S' is true or S' is false, that is (31c; $\Box_s[S'] \vee \Box_s\neg[S']$). Being opinionated about an alternative has non-trivial consequences: if it is the case the speaker believes S (31a; from the Maxim of Quality), but it is not the case that the speaker believes S' (i.e. ignorance, 31b; from the Maxim of Quantity), and the speaker is opinionated about S' (31c), then it logically follows that the speaker believes S' to be false, as demonstrated in (31d). The reason is that the opinion that S' is true is neutralised by the ignorance inference about S', while the opinion that S' is false remains untouched.

(31) a. **Primary belief:**
The speaker believes S to be true. $\Box_s(S)$
b. **Ignorance:**
It is not the case that the speaker believes S'. $\neg\Box_s(S')$
c. **Opinion:**
The speaker believes S' to be true or false. $\Box_s(S') \vee \Box_s\neg(S')$
d. **Inference:**
The speaker believes S' to be false. $(\Box_s(S') \vee \Box_s\neg(S')) \wedge \neg\Box_s(S') \Leftrightarrow \Box_s\neg(S')$

For disjunction, a speaker can, in principle, be opinionated about each of the three possible scenarios, that is, the individual disjuncts (32)[ab] and their conjunction (32c).

(32) **Speaker's possible opinions:**
a. The speaker has an opinion on whether Liz bought a croissant. $\Box_s(P) \vee \Box_s\neg(P)$
b. The speaker has an opinion on whether Liz bought a donut. $\Box_s(Q) \vee \Box_s\neg(Q)$
c. The speaker has an opinion on whether Liz bought a croissant and a donut.
$\Box_s(P \wedge Q) \vee \Box_s\neg(P \wedge Q)$

However, maintaining this full set of opinions leads to inconsistencies in the reasoning. Specifically, being opinionated about the individual disjuncts yields a contradiction with prior

beliefs. This is illustrated step-by-step in (33). Suppose a scenario in which the speaker believes that Liz bought a croissant or a donut (33a), is ignorant about which pastry Liz bought (33b), but nonetheless has an opinion about whether Liz bought a croissant (33c). Then, it logically follows that the speaker believes that Liz did not buy a croissant (33d). However, since the speaker also believes the disjunction to be true (33a), this entails that the speaker believes that Liz bought the donut and not the croissant (33e). This entailment is undesirable as the resulting belief clashes with the formerly derived ignorance inference that it is not the case that the speaker believes Liz bought a donut (33f).

(33) **Opinion about the individual disjuncts generates a contradiction:**

a. **Primary belief:**
$\Box_s(P \vee Q)$

b. **Ignorance inferences:**
(i) About the croissant: $\neg\Box_s(P)$
(ii) About the donut: $\neg\Box_s(Q)$
(iii) About the conjunctive alternative: $\neg\Box_s(P \wedge Q)$

c. **Opinion about the croissant:**
$\Box_s(P) \vee \Box_s\neg(P)$

d. **Inference about the croissant:**
$(\Box_s(P) \vee \Box_s\neg(P)) \wedge \neg\Box_s(P) \Leftrightarrow \Box_s\neg(P)$

e. **Undesired entailment about the donut:**
$\Box_s(P \vee Q) \wedge \Box_s\neg(P) \Leftrightarrow \Box_s(Q) \wedge \Box_s\neg(P)$

f. **Contradiction between (33b) and (33e):**
$\Box_s\neg(P) \wedge \Box_s(Q) \wedge \neg\Box_s(Q) \Leftrightarrow \bot$

This contradiction shows that the speaker cannot be opinionated about the individual disjuncts without endangering the consistency of the reasoning. In contrast, no contradiction arises when the speaker is only opinionated about the conjunctive alternative. If the speaker is uncertain about whether Liz bought both a croissant and a donut (34b), but holds an opinion about this very same alternative (34c), then it follows that the speaker believes that Liz did not buy both a croissant and a donut (34d; i.e. the desired exclusivity inference).

(34) **Exclusivity inference in simple disjunction:**

a. **Primary belief:**
$\Box_s(P \vee Q)$

b. **Ignorance inferences:**
(i) About the croissant: $\neg\Box_s(P)$
(ii) About the donut: $\neg\Box_s(Q)$
(iii) About the conjunctive alternative: $\neg\Box_s(P \wedge Q)$

c. **Opinion about the conjunctive alternative:**
$\Box_s(P \wedge Q) \vee \Box_s\neg(P \wedge Q)$

d. **Exclusivity inference:**
$[\Box_s(P \wedge Q) \vee \Box_s\neg(P \wedge Q) \wedge \neg\Box_s(P \wedge Q)] \Leftrightarrow \Box_s\neg(P \wedge Q)$

As illustrated in (35), the belief that the conjunctive alternative is false is consistent with both the speaker's primary belief and the ignorance inferences.

(35) a. $\underbrace{\Box_s(P \vee Q)}_{\text{Primary belief}} \wedge \underbrace{\neg\Box_s(P) \wedge \neg\Box_s(Q) \wedge \neg\Box_s(P \wedge Q)}_{\text{Ignorance inferences}} \wedge \underbrace{\Box_s(P \wedge Q) \vee \Box_s\neg(P \wedge Q)}_{\text{Opinion}}$

b. (35a) $\Leftrightarrow \underbrace{\Box_s(P \vee Q)}_{\text{Primary belief}} \wedge \underbrace{\neg\Box_s(P) \wedge \neg\Box_s(Q)}_{\text{Ignorance inferences}} \wedge \underbrace{\Box_s\neg(P \wedge Q)}_{\text{Exclusivity inference}}$

After calculating the exclusivity inference, the speaker now believes that her utterance is true (36a) and that the conjunctive alternative is false (36d), while she is unsure about whether Liz bought a croissant (36b) and whether Liz bought a donut (36c).

(36) **Status of the speaker's beliefs after calculating the exclusivity inference:**
   a. The speaker believes that Liz bought a croissant or a donut. $\Box_s(P \vee Q)$
   b. $\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a croissant. $\neg\Box_s(P)$
   c. $\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a donut. $\neg\Box_s(Q)$
   d. $\rightsquigarrow$ The speaker believes that it is not the case that Liz bought a croissant and a donut. $\Box_s\neg(P \wedge Q)$

It is worth noting that in order to derive an exclusivity inference, ignorance must first be established. In other words, the exclusivity inference necessarily arises hand in hand with ignorance inferences. As will be shown in Section 3, these ignorance inferences are unavoidable and play a crucial role in the strengthening process of the literal meaning of a sentence to a stronger one.

2.4 Modal disjunction and the problem of the free choice interpretation

This section focuses on modal disjunctive statements (i.e., disjunctive statements embedded under a modal operator) and their characteristic inference, the free choice inference, which raises a challenge for the traditional pragmatic approach to scalar implicatures. This is motivated by two reasons: first, modal disjunction constitutes a central theme of this book that will be fully investigated in Chapter 5, in which we demonstrate that children are not adult-like with such constructions, contrary to the conclusions of previous studies on the same topic. Second, as will be shown in what follows, the classic Gricean approach to scalar implicatures encounters significant limitations when applied to modal disjunction, in particular in deriving the free choice interpretation. These limitations provide the basis for the grammatical approach to scalar implicatures presented in Section 3, which models scalar implicatures within the compositional system, an essential step toward accounting for children's overall performance with disjunction.

Consider the contrast between a simple disjunction in (37) and modal disjunction in (38). On the one hand, the simple disjunctive statement in (37) gives rise to an exclusivity inference in (37c), that Liz did not buy both a croissant and a donut, and to the ignorance inferences in (37b), that the speaker does not know which pastry Liz bought. On the other hand, the modal disjunctive statement in (38) appears to license the opposite conjunctive inference in (38b) that Liz has the possibility to buy a croissant and she has the possibility to buy a donut. In other words, Liz is granted both possibilities: she is free to choose between the two individual pastries. This reading is traditionally referred to as the free choice interpretation ($\Diamond P \wedge \Diamond Q$; von Wright, 1968; Kamp, 1974). Interestingly, (38) also licenses the inference that Liz is not allowed to choose both pastries together (38c; $\neg\Diamond[P \wedge Q]$), namely an exclusivity inference.[11] Finally, contrary to simple disjunction, no visible ignorance inference seems to be preserved in modal disjunction. Put differently, it appears that ignorance is fully resolved in (38).

[11] Note that there is no contradiction between deriving an exclusivity inference and a free choice inference. See Section 3.3.1 for further details.

(37) Liz bought a croissant or a donut. "P or Q"

a. **Literal inclusive meaning:**
Liz bought a croissant or a donut, possibly both. $(P \vee Q)$

b. **Ignorance inference:**
$\rightsquigarrow$ Liz bought a croissant or a donut, but we do not know which.

c. **Exclusivity inference:**
$\rightsquigarrow$ Liz bought a croissant or a donut, but not both. $\neg(P \wedge Q)$

(38) Liz can buy a croissant or a donut. "Can P or Q"

a. **Logical meaning:**
Liz can buy a croissant or a donut, possibly both. $\Diamond(P \vee Q)$

b. **Free Choice inference:**
$\rightsquigarrow$ Liz can buy a croissant and Liz can buy a donut. $\Diamond P \wedge \Diamond Q$

c. **Exclusivity inference:**
$\rightsquigarrow$ Liz cannot buy both the croissant and the donut. $\neg\Diamond(P \wedge Q)$

Importantly, the free choice interpretation does not follow from the sole interplay of standard deontic logic and the literal inclusive meaning of disjunction. For instance, in deontic logic, a modal disjunctive statement is not equivalent to the conjunction of the two modal disjuncts (39; $\Diamond P \wedge \Diamond Q$) unlike negated disjunction (see 17, Section 1.3), nor can it be made an axiom of the system (Kamp, 1974). This problem is also known as the Paradox of Free Choice Permission (von Wright, 1968).

(39) $\Diamond(P \vee Q) \nLeftrightarrow \Diamond P \wedge \Diamond Q$ Paradox of Free Choice Permission

To further illustrate this paradox, suppose that (40) is an axiom of the system. Then, as demonstrated in (41), one can derive the truth of any proposition from the premise. This would render the whole system unstable and, as such, is an undesirable outcome.

(40) $\Diamond(P \vee Q) \rightarrow \Diamond P$ Free Choice principle

(41) a. $\Diamond P$ Premise
b. $\Diamond(P \vee Q)$ From (41a) by disjunction introduction[12]
c. $\Diamond Q$ From (41b) by free choice principle (40)

To avoid this paradox, many authors have proposed that free choice effects are best analysed as implicatures, rather than as semantic entailments (Alonso-Ovalle, 2005; Gazdar, 1979; Kratzer & Shimoyama, 2002; among others). A key piece of evidence in favour of this view is that free choice effects disappear under negation (Alonso-Ovalle, 2005). For instance, in (42), the only available interpretation is that neither dessert is permitted, a reading also referred to as dual prohibition (42a – 43a). Essentially, it does not convey that the addressee is not free to choose between the two desserts (42b – 43b).

[12] Disjunction Introduction, also referred to as Addition, is a valid principle in both classical and deontic logic. Formally, it states that from a proposition P, one may infer the disjunction $(P \vee Q)$, regardless of the content of Q. This extends to modal logic: from $\Diamond P$, one may infer $\Diamond(P \vee Q)$, as shown in (ia). However, this rule hardly translates to natural language as, given the premise in (ib), it seems incorrect to conclude (ic).

(i) a. $\Diamond P \rightarrow \Diamond(P \vee Q)$
b. Liz may eat a croissant.
c. Liz may eat a croissant or she may go to the library.

(42) You are not allowed to eat the cake or the ice-cream.
   a. $\rightsquigarrow$ It is not allowed to eat the cake and it is not allowed to eat the ice-cream.
   b. $\neq$ It is not the case that [you are allowed to eat the cake and you are allowed to eat the ice-cream].

(43) a. $\neg\Diamond(P \vee Q) \Leftrightarrow \neg\Diamond P \wedge \neg\Diamond Q$ (42a)
   b. $\neg\Diamond(P \vee Q) \not\Leftrightarrow \neg(\Diamond P \wedge \Diamond Q)$ (42b)

While these observations support an implicature account of the free choice interpretation, the Gricean account presented in previous sections encounters difficulties in deriving it. Suppose that, like simple disjunction, modal disjunction introduces the set of alternatives listed in (44). This set includes the modal disjunctive statement, the individual modal disjuncts and the modal conjunctive alternative.[13]

(44) a. ALT(Liz can buy a croissant or a donut) = {Liz can buy a croissant,
   Liz can buy a donut,
   Liz can buy a croissant and a donut}
   b. $ALT(\Diamond[P \vee Q]) = \{\Diamond P, \Diamond Q, \Diamond(P \wedge Q)\}$

Given the belief in (45), the traditional pragmatic account would predict ignorance inferences like those in (46), just as in the case of simple disjunction. However, the free choice interpretation does not match this prediction: it requires that the speaker believes that each disjunct is possible, rather than being uncertain about each possibility.

(45) **Speaker's primary belief (Maxim of Quality):**
The speaker believes that Liz can buy a croissant or a donut. $\Box_s(\Diamond[P \vee Q])$

(46) **Ignorance inferences for "Liz can buy a croissant or a donut":**
   a. $\rightsquigarrow$ It is not the case that the speaker believes that Liz can buy a croissant. $\neg\Box_s(\Diamond P)$
   b. $\rightsquigarrow$ It is not the case that the speaker believes that Liz can buy a donut. $\neg\Box_s(\Diamond Q)$
   c. $\rightsquigarrow$ It is not the case that the speaker believes that Liz can buy a croissant and a donut. $\neg\Box_s(\Diamond[P \wedge Q])$

The ignorance inferences in (46) are too weak: the speaker has to be more than open to the possibility that Liz can buy any of the two desserts. Instead, the speaker must be certain that Liz has the possibility to buy the croissant (47a) and certain that Liz has the possibility to buy the donut (47b).

(47) **Desired beliefs for "Liz can buy a croissant or a donut":**
   a. $\rightsquigarrow$ The speaker believes that Liz can buy a croissant. $\Box_s(\Diamond P)$
   b. $\rightsquigarrow$ The speaker believes that Liz can buy a donut. $\Box_s(\Diamond Q)$

One might attempt to resolve this issue by supposing that the speaker is opinionated about the individual disjuncts. However, as with simple disjunction, doing so in the case of modal disjunction leads to a contradiction with the previously derived ignorance inferences. Take (48) as an illustration. In this example, the speaker believes her utterance to be true (48a) and draws the ignorance inferences in (48b). But she is also taken to be opinionated about whether

[13] Notice that, although the possibility modal $\Diamond$ has the necessity modal $\Box$ as its scalar counterpart, $\Box$ alternatives were not included in the set alternatives to reason with. This is both to avoid clutter in the formulas but also because these alternatives are irrelevant in the generation of the free choice interpretation.

Liz bought a croissant (48c). From this, it follows that the speaker believes that Liz did not buy a croissant (48d), and, consequently, that she must have bought a donut (48e). However, this contradicts the earlier ignorance inference that it is not the case that the speaker believes that Liz bought a donut (48f).

(48) **Opinion about the modal individual disjuncts generates a contradiction:**

a. **Primary belief:**
$\Box_s(\Diamond[P \vee Q])$

b. **Ignorance inferences:**
(i) About the possibility to buy the croissant: $\neg\Box_s(\Diamond P)$
(ii) About the possibility to buy the donut: $\neg\Box_s(\Diamond Q)$
(iii) About the possibility to buy both pastries: $\neg\Box_s(\Diamond[P \wedge Q])$

c. **Opinion about the possibility to buy the croissant:**
$\Box_s(\Diamond P) \vee \Box_s\neg(\Diamond P)$

d. **Inference about the possibility to buy the croissant:**
$(\Box_s(\Diamond P) \vee \Box_s\neg(\Diamond P)) \wedge \neg\Box_s(\Diamond P) \Leftrightarrow \Box_s\neg(\Diamond P)$

e. **Undesired entailment about the possibility to buy the donut:**
$\Box_s(\Diamond[P \vee Q]) \wedge \Box_s\neg(\Diamond P) \Leftrightarrow \Box_s\neg(\Diamond P) \wedge \Box_s(\Diamond Q)$

f. **Contradiction between (48b-ii) and (48e):**
$\Box_s\neg(\Diamond P) \wedge \Box_s(\Diamond Q) \wedge \neg\Box_s(\Diamond Q) \Leftrightarrow \bot$

The only alternative about which the speaker can be opinionated without jeopardizing the reasoning is the conjunctive alternative. However, endorsing this alternative does not result in a free choice inference, but rather in an exclusivity inference. If the speaker is uncertain about whether Liz can buy both a croissant and a donut (49b-iii), but holds an opinion about this very same alternative (49c), then it follows that the speaker believes that Liz cannot buy both a croissant and a donut (49d).

(49) **Exclusivity inference in modal disjunction:**

a. **Primary belief:**
$\Box_s(\Diamond[P \vee Q])$

b. **Ignorance inferences:**
(i) About the croissant: $\neg\Box_s(\Diamond P)$
(ii) About the donut: $\neg\Box_s(\Diamond Q)$
(iii) About the conjunctive alternative: $\neg\Box_s(\Diamond[P \wedge Q])$

c. **Opinion about the conjunctive alternative:**
$\Box_s(\Diamond[P \wedge Q]) \vee \Box_s\neg(\Diamond[P \wedge Q])$

d. **Exclusivity inference:**
$(\Box_s(\Diamond[P \wedge Q]) \vee \Box_s\neg(\Diamond[P \wedge Q])) \wedge \neg\Box_s(\Diamond[P \wedge Q]) \Leftrightarrow \Box_s\neg(\Diamond[P \wedge Q])$

As illustrated in (50), the belief that the conjunctive alternative is false is compatible with both the speaker's primary belief and the ignorance inferences.

(50) a. $\underbrace{\Box_s(\Diamond[P \vee Q])}_{\text{Primary belief}} \wedge$

$\underbrace{\neg\Box_s(\Diamond P) \wedge \neg\Box_s(\Diamond Q) \wedge \neg\Box_s(\Diamond[P \wedge Q])}_{\text{Ignorance inferences}} \wedge \underbrace{\Box_s(\Diamond[P \wedge Q]) \vee \Box_s\neg(\Diamond[P \wedge Q])}_{\text{Opinion}}$

b. (50a) $\Leftrightarrow \underbrace{\Box_s(\Diamond[P \vee Q])}_{\text{Primary belief}} \wedge \underbrace{\neg\Box_s(\Diamond P) \wedge \neg\Box_s(\Diamond Q)}_{\text{Ignorance inferences}} \wedge \underbrace{\Box_s\neg(\Diamond[P \wedge Q])}_{\text{Exclusivity inference}}$

After calculating the exclusivity inference, the speaker now believes that her utterance is true (51a) and that the conjunctive alternative is false (51d), while she is unsure about whether Liz can buy a croissant (51b) whether Liz can buy a donut (51c).

(51) **Status of the speaker's beliefs after calculating the exclusivity inference:**
   a. The speaker believes that Liz can buy a croissant or a donut. $\Box_s(\Diamond[P \vee Q])$
   b. $\rightsquigarrow$ It is not the case that the speaker believes that Liz can buy a croissant. $\neg\Box_s(\Diamond P)$
   c. $\rightsquigarrow$ It is not the case that the speaker believes that Liz can buy a donut. $\neg\Box_s(\Diamond Q)$
   d. $\rightsquigarrow$ The speaker believes that it is not the case that Liz can buy a croissant and a donut. $\Box_s\neg(\Diamond[P \wedge Q])$

Unless we revise the semantics of disjunction or alter the derivational machinery, as in Geurts (2005, 2011), the (Neo-)Gricean framework lacks the tools to derive free choice inferences. In the next section, we introduce the grammatical account to scalar implicatures, which provides the adequate toolbox to capture this inference.

3 The grammatical approach to scalar implicatures

This section introduces the grammatical approach to scalar implicatures, which models pragmatic enrichment through the insertion of an exhaustivity operator (*Exh*) at the syntactic level. *Exh* takes a proposition together with its set of alternatives and strengthens its meaning by negating as many alternatives as possible. Crucially, this operation can apply recursively during meaning composition and at different points in the syntactic structure, provided the *Exh* operator meets its licensing conditions.

Unlike the traditional Gricean approach, which treats scalar implicatures as purely pragmatic reasoning, the grammatical approach frames scalar implicature at the compositional level, which allows it to account for a broader range of phenomena. In particular, it derives free choice inferences and other conjunctive readings of disjunction that are problematic for the Gricean view. It also provides a more fine-grained framework for understanding children's non-adult-like reasoning with scalar implicatures. For instance, as will be argued in this book, we propose that children tend to resolve ignorance inferences as early (i.e., as low in the syntactic structure) as possible, a preference that is naturally captured under a grammatical model but not under a traditional pragmatic one.

The section is structured as follows. Section 3.1 presents an updated algorithm for generating alternatives via systematic syntactic operations. Section 3.2 introduces the exhaustification procedure developed by Fox (2007) and illustrates how exclusivity inferences arise within this system. Section 3.3 extends the same procedure to conjunctive interpretations of disjunction, including free choice inferences, the conjunctive reading of disjunction in adult Warlpiri, and non-adult-like conjunctive interpretations in child language.

3.1 A syntactic algorithm to generate alternatives

One of the crucial components of the grammatical approach to scalar implicatures is a systematic procedure for generating alternatives. In the traditional Gricean view, alternatives are pragmatically retrieved based on conversational reasoning and the listener's world knowledge. In contrast, the grammatical approach seeks to make the process fully compositional and

syntactically constrained, so that the *Exh* operator operates on a well-defined set of structurally generated alternatives.

According to Katzir (2007), alternatives are generated by structural replacements in the syntax. Fox and Katzir (2011) refine this proposal, making it systematic by distinguishing between two major kinds of operations: substitution with members of a Horn scale (52b; yielding scalar alternatives) and the replacement of constituents with structurally simple ones (52c; yielding subdomain alternatives). Fox and Katzir further argue that the set of alternatives to a sentence necessarily includes its prejacent (52a; i.e., its literal meaning), a crucial departure from the Gricean framework. As will be shown in the next section, the prejacent plays a key role in maintaining consistency in the reasoning. Moreover, as will be shown in Section 3.3.3, this syntactic approach to generating alternatives is critical for acquisition studies. For instance, Singh et al. (2016) argue that children's difficulties with scalar implicatures may arise from their inability to perform specific lexical substitutions (e.g., replacing *or* with *and*).

(52) **Algorithm for generating alternatives to a sentence S:**
   a. **Prejacent:** The sentence S itself is always included in its own set of alternatives.
   b. **Lexical substitution:** Replace scalar items (e.g., *or*, *some*, *possible*) with stronger items on the same Horn scale (e.g., *and*, *all*, *certain*).
   c. **Structural replacement:** Replace constituents with structurally simpler expressions, including subconstituents of the sentence.

The algorithm applied to disjunction is summarised in (53). The set of alternatives includes the prejacent (53a), its scalar-mate (the conjunctive alternative; 53bc), and its subconstituents (the individual disjuncts; 53d). The resulting set of alternatives is given in (54). For the remainder of this book, we will assume that the set of alternatives for disjunction is systematically generated that way.

(53) **Algorithm to generate the set of alternatives for $(P \vee Q)$:**
   a. **Prejacent:** Liz bought a croissant or a donut. $(P \vee Q)$
   b. **Horn scale for $(P \vee Q)$:** $< or, and >$ $< \vee, \wedge >$
   c. **Lexical replacement:** Liz bought a croissant and a donut. $(P \wedge Q)$
   d. **Structural replacement:**
      (i) Liz bought a croissant ~~or a donut~~. = Liz bought a croissant. P
      (ii) Liz bought ~~a croissant or~~ a donut. = Liz bought a donut. Q

(54) **Set of alternatives of $(P \vee Q)$:**
$ALT(P \vee Q) = \{(P \vee Q), P, Q, (P \wedge Q)\}$

3.2 The exhaustification procedure

This section presents the exhaustification procedure, a formalised pragmatic reasoning that introduces an exhaustivity operator *Exh* as the core mechanism behind the derivation of scalar implicatures. Section 3.2.1 uncovers the inner workings of this procedure as formulated by Fox (2007), while Section 3.2.2 clarifies the licensing conditions that trigger this procedure.

3.2.1 Covert Exhaustivity operator and Innocent Exclusion Procedure

Consider the examples in (55) and (56).

(55) a. Liz bought a croissant or a donut.
   b. $\rightsquigarrow$ Liz bought a croissant or a donut, but not both.

(56) a. Liz *only* bought a croissant OR a donut. [pitch accent on "or"]
b. **Understood:** Liz bought a croissant or a donut, but not both.

Intuitively, both (55) and (56) convey the exclusive interpretation that Liz did not buy both the croissant and the donut. In particular, the scalar implicature that arises implicitly in the simple disjunctive statement in (55) appears to be made explicit in (56a) through the presence of the focus-sensitive operator *only*, paired with a pitch accent on the disjunction (Fox, 2007). To make this more explicit, let (57) serve as a paraphrase for (56).

(57) **Paraphrase for (56):**
a. The only acceptable situations are those where Liz bought exactly one pastry, either a croissant or a donut.
b. Every other situation is not acceptable, that is to say, the situation where Liz bought both a croissant and a donut is not acceptable.

This paraphrase clearly illustrates that the function of *only* is to exclude stronger alternatives from the set of acceptable outcomes. Put differently, natural languages appear to possess lexical items, such as English *only*, that allow speakers to express strengthened meanings. In this case, *only* presupposes the truth of the prejacent and asserts the falsity of stronger alternatives (Alxatib, 2014), essentially producing what looks like an overt scalar implicature.

Building on this observation, and following earlier proposals from Kratzer and Shimoyama (2002) and Alonso-Ovalle (2005), among others, Fox (2007) posits that the adult grammar incorporates a covert exhaustivity operator, *Exh*, which is functionally analogous to *only*.[14] Fox argues that this covert *Exh* operator is responsible for generating strengthened interpretations, including both exclusive and free choice readings. Crucially, since *Exh* is implemented at the syntactic level, it can attach to any sentence S to yield an enriched interpretation $S+$, (58).

(58) $Exh(ALT(S))(S) \Leftrightarrow S^{+}$

Intuitively, *Exh* asserts the prejacent, S, and negates all *relevant* stronger alternatives in the set of alternatives of S, $ALT(S)$, to derive the enriched interpretation, $S+$. However, not all alternatives are legitimate candidates for negation. One might be tempted to define the *Exh* operator simply as in (59), that is, as an operator that negates all stronger alternatives to the prejacent. However, as it will be demonstrated below, this approach leads to outright contradiction.

(59) $[\![Exh]\!](\text{ALT})(p)(w) \Leftrightarrow p(w) \wedge \forall q \in \text{Stronger}(p, \text{ALT})[\neg q(w)]$

To illustrate why this naive definition of the *Exh* operator leads to contradictions, consider first the desired effect of the exhaustification procedure for a simple disjunctive statement in (60).

[14] Note, however, that *Exh* should not be mistaken with a covert *only*. As pointed out by Alxatib (2014), *Exh* and *only* differ on some aspects of the reasoning. In particular, while *Exh* asserts the prejacent, *only* presupposes it. This means that with *Exh*, the truth of the prejacent is part of the at-issue content and can be straightforwardly targeted by operators such as negation. In contrast, *only* takes the prejacent for granted, making it project outside of the scope of such operators. For example, compare (ia) and (ib).

(i) a. It is not the case that Liz bought a croissant or a donut.
b. It is not the case that Liz only bought a croissant or a donut.

Whereas (ia) clearly denies Liz buying either pastry (in English), (ib) denies that Liz bought only those things, but still presupposes she bought a croissant or a donut.

(60) **Expected exhaustification procedure for "*Liz bought a croissant or a donut*":**
a. Given the set of alternatives $ALT(P \vee Q) = \{(P \vee Q), P, Q, (P \wedge Q)\}$
b. $Exh(ALT[P \vee Q])(P \vee Q) \Leftrightarrow (P \vee Q) \wedge \neg(P \wedge Q)$
c. $Exh(ALT[\text{Liz bought a croissant or a donut}])(\text{Liz bought a croissant or a donut})$
$\Leftrightarrow$ Liz bought a croissant or a donut, but not both.

Appending *Exh* to a simple disjunctive statement must result in the derivation of an exclusive interpretation (i.e. Liz bought a croissant or a donut, but not both), arising from the negation of the conjunctive alternative (60bc). Given the set of alternatives in (60a), that includes both the individual disjuncts and the conjunctive alternative, only the latter should be negated during the exhaustification process.

However, if the operator were defined as in (59) and naively negated all stronger alternatives, including the individual disjuncts P and Q, it would produce a blatant contradiction, as illustrated in (61). In this case, the strengthened interpretation would assert that Liz bought a croissant or a donut, while simultaneously denying that she bought a croissant and also denying that she bought a donut. This clearly leads to a contradiction, demonstrating that not all alternatives can be negated indiscriminately in the exhaustification procedure.

(61) **Undesired exhaustification procedure if *Exh* = (59):**
a. Given the set of alternatives $\text{ALT}(P \vee Q) = \{(P \vee Q), P, Q, (P \wedge Q)\}$
b. $Exh(\text{ALT}[P \vee Q])(P \vee Q) \Leftrightarrow (P \vee Q) \wedge \neg P \wedge \neg Q \wedge \neg(P \wedge Q)$
$\Leftrightarrow \bot$

Exh needs to be smarter and must carry the crucial property of being able to single out which alternatives are legitimate candidates for negation without generating a contradiction. To solve this problem, Fox (2007) introduces the notion of Innocent Exclusion, a filtering mechanism that selects for negation only those alternatives whose negation, together with other alternatives, does not contradict the prejacent. Alternatives that pass this filter are referred to as the Innocently Excludable alternatives. The set of all such alternatives, abbreviated as ALT^{IE}, is defined by the Innocent Exclusion function, given in (62).

(62) **Innocent Exclusion function:** (Fox, 2007; p. 25)
$\text{IE}(p, ALT) = \cap(ALT' \subseteq ALT : ALT'$ is a maximal subset of ALT,
such that $\{\neg q : q \in ALT'\} \cup \{p\}$ is consistent)

This function is paraphrased as follows: the set of Innocently Excludable alternatives of a sentence S, $ALT^{\text{IE}}(S)$, is the intersection of every maximal subset of $ALT(S)$ whose members can be negated consistently with the prejacent. The notion of maximal subset is defined below in (63). Maximal subsets are sets that maximally include as many alternatives of $ALT(S)$ as possible that can be negated together as long as it does not contradict the prejacent of S. This will be illustrated further below with disjunction.

(63) **Maximal subset:**
A subset $\text{ALT}' \subseteq \text{ALT}(S)$ is *maximal* iff the prejacent S can be consistently asserted together with the negations of all members in ALT′, and no strict superset of ALT′ has this property.

Fox (2007) thus proposes the revised lexical entry in (64) for *Exh* that incorporates the Innocent Exclusion function. This revised version of *Exh* takes a prejacent p and a set of alternatives ALT, then returns a strengthened sentence from which all Innocently Excludable

alternatives have been negated.

(64) **Exhaustivity operator:** (Fox, 2007; p. 25)
$[\![Exh]\!](ALT)(p)(w) \Leftrightarrow p(w) \wedge \forall q \in \mathrm{IE}(p, ALT)[\neg q(w)]$

The exhaustification procedure of a simple disjunctive statement is detailed step by step in the following examples. For the exhaustification of modal disjunction, which requires additional assumptions, see Section 3.3.1.

Consider the set of alternatives of a simple disjunctive statement, reproduced here in (65). This set has two maximal subsets: (66a) and (66b). As shown in (67), asserting the prejacent and negating all members of either of these sets does not lead to a contradiction.

(65) **Set of alternatives for** $(P \vee Q)$**:**
$ALT(P \vee Q) = \{\underbrace{(P \vee Q)}_{\text{Prejacent}}, \underbrace{P \ , \ Q}_{\substack{\text{Individual} \\ \text{disjuncts}}}, \underbrace{(P \wedge Q)}_{\substack{\text{Conjunctive} \\ \text{alternative}}}\}$

(66) **Maximal subsets of** $(P \vee Q)$**:**
a. $\{P, (P \wedge Q)\}$
b. $\{Q, (P \wedge Q)\}$

(67) a. $(P \vee Q) \wedge \neg P \wedge \neg(P \wedge Q) \Leftrightarrow Q$
b. $(P \vee Q) \wedge \neg Q \wedge \neg(P \wedge Q) \Leftrightarrow P$

The subsets containing the individual disjuncts in (68a), or the prejacent itself[15] in (68b), are not maximal subsets because negating their members while asserting the prejacent leads to the contradictions in (69ab). The subset that includes the conjunctive alternative (68c) does not yield any contradiction with the prejacent per se. But this subset did not include as many alternatives as possible. Specifically, this subset can be enlarged by adding either of the individual disjuncts. Consequently, it is not considered to be maximal.

(68) **Non-maximal subsets of** $ALT(P \vee Q)$**:**
a. $\{P, Q\}$ [yields a contradiction, ((69a))]
b. $\{(P \vee Q)\}$ [yields a contradiction, ((69b))]
c. $\{(P \wedge Q)\}$ [can be enlarged]

(69) a. $(P \vee Q) \wedge \neg P \wedge \neg Q \Leftrightarrow \bot$
b. $(P \vee Q) \wedge \neg(P \vee Q) \Leftrightarrow \bot$

The set of Innocently Excludable alternatives of $(P \vee Q)$ is defined as the intersection of the two maximal subsets identified in (67a) and (67b), which contains only the conjunctive alternative, as shown in (70).

(70) **Set of Innocently Excludable alternatives of** $(P \vee Q)$**:**
$ALT^{\mathrm{IE}}(P \vee Q) = \{P, (P \wedge Q)\} \cap \{Q, (P \wedge Q)\}$
$= \{(P \wedge Q)\}$

The derivation, given in (71), is paraphrased as follows: *Exh* asserts the inclusive meaning of disjunction (i.e. the prejacent), and negates every member of the set of Innocently Excludable

[15] In fact, each subset that is composed of the prejacent and any other alternatives would lead to a contradiction. To avoid clutter in the examples, these subsets are not listed here.

alternatives (i.e. $ALT^{\text{IE}}[P \vee Q]$), namely, the conjunctive alternative, thereby yielding the exclusive interpretation.

(71) $$Exh(ALT(P \vee Q))(P \vee Q) \Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\text{IE}}(P \vee Q))}_{\text{Negating IE Alternatives}}$$
$$\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(P \wedge Q)}_{\text{Exclusivity}}$$

The whole exhaustification procedure is summarised below in (72).

(72) **Exhaustification procedure:**
- a. **Step 1:** Take a sentence S and its set of alternatives $ALT(S)$.
  E.g. $(P \vee Q)$ and $ALT(P \vee Q) = \{(P \vee Q), P, Q, (P \wedge Q)\}$
- b. **Step 2:** Append *Exh* to S such that the sentence is interpreted as $Exh(ALT[S])(S)$.
  E.g. $Exh(ALT[P \vee Q])(P \vee Q)$
- c. **Step 3:** Apply the Innocent Exclusion procedure.
  E.g. $ALT^{\text{IE}}(P \vee Q) = \{P, (P \wedge Q)\} \cap \{Q, (P \wedge Q)\} \Leftrightarrow \{(P \wedge Q)\}$
- d. **Step 4:** Assert the prejacent and assign false to every member of $ALT^{\text{IE}}(S)$.
  E.g. Assert $(P \vee Q)$ and negate $(P \wedge Q)$ to yield $(P \vee Q) \wedge \neg(P \wedge Q)$

3.2.2 Licensing *Exh* and Recursive Exhaustification

While the *Exh* operator can, in principle, be appended to any sentence S to generate an enriched meaning, it does not apply blindly and must be licensed. To this end, Fox (2007) proposed the parsing strategy in (73) which licenses the insertion of *Exh* whenever a sentence gives rise to an ignorance inference. Importantly, in Fox's (2007) exhaustification framework, ignorance inferences are not derived by the exhaustification operator itself. Instead, these inferences are derived exactly as they were derived in the (Neo-)Gricean framework, that is, from the interaction of the Maxims of Quality and Quantity.[16]

(73) ***Exh* parsing strategy:** (Fox, 2007; p. 28)
If a sentence S has an undesirable Ignorance Inference, parse it as $Exh(ALT(S))(S)$.

Assuming that the speaker adheres to the Cooperative Principle, uttering a sentence that carries ignorance inferences violates the Maxim of Quality. Specifically, it contradicts the injunction not to say anything for which one lacks adequate evidence. Therefore, the ignorance inferences arising from simple disjunctive statements, repeated below in (74), are considered to be undesirable. The exhaustification procedure has been designed such that one of its main features is to eliminate these undesirable inferences.

(74) **Ignorance inferences for "*Liz bought a croissant or a donut.*":**
- a. $\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a croissant.
- b. $\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a donut.
- c. $\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a croissant and a donut.

Before the derivation of the exclusive interpretation, the speaker remains open to all

[16] See Meyer (2013) and Buccola and Haida (2019) for an alternative approach where ignorance inferences are derived through the interaction of a covert exhaustivity operator and a covert doxastic operator. For the present book, we will adopt the traditional Gricean way of deriving these inferences.

possibilities. In other words, at this stage, the hearer infers that the speaker is completely ignorant about what Liz actually did. Consequently, the *Exh* parsing strategy applies and triggers the exhaustification procedure. After the derivation of the exclusivity inference, part of the initial ignorance has been resolved: the hearer now infers that the speaker is certain that Liz did not buy both desserts.

The *Exh* operator can thus be viewed as a general mechanism in natural language that seeks to resolve as much ignorance as possible by generating enriched meanings. Importantly, following the parsing strategy in (73), *Exh* can apply to its own output (i.e., recursively), as long as there remains undesirable ignorance to be cleared. Consider (75) as an illustration. Note the superscript plus sign which indicates that the statement underwent a round of exhaustification. Suppose that the strengthened version of a sentence S, denoted S^+, still carries ignorance inferences that were not cleared during the first round of exhaustification. In such case, *Exh* is licensed again and can be appended to S^+, yielding an even stronger sentence S^{++} (75c).

(75)
a. S — Check for ignorance (Quality + Quantity)
b. $Exh(ALT[S])(S) \Leftrightarrow S^+$ — If S has ignorance, append *Exh* to S
c. $Exh(ALT[S^+])(S^+) \Leftrightarrow S^{++}$ — If S^+ has ignorance, append *Exh* to S^+
d. $Exh(ALT[S^{++}])(S^{++}) \Leftrightarrow S^{+++}$ — If S^{++} has ignorance, append *Exh* to S^{++}
e. ...

Importantly, the set of alternatives for any subsequent round of exhaustification after the first one is always the enriched version of the alternatives used in the previous round. For instance, consider that S has the set of alternatives in (76a). Now, suppose that S underwent a round of exhaustification, resulting in an enriched statement S^+. When calculating the alternatives for S^+, the new set of alternatives is not generated from scratch. Instead, each member of the original set of alternatives of S is exhaustified to give rise to a set of enriched alternatives. In other words, the reasoning at this stage is still based on the full set of alternatives of S (as explicitly shown in 76b). Each enriched alternative (e.g., α^+) is formed by applying *Exh*to the base alternative (α) with respect to the entire original set of alternatives $ALT(S)$ ($\{\alpha, \beta, \gamma\}$).

(76) **Deriving enriched alternatives:**
a. $ALT(S) = \{\alpha, \beta, \gamma\}$
b. $ALT(S^+) = \{\alpha^+, \beta^+, \gamma^+\}$
Where:
(i) $\alpha^+ \Leftrightarrow Exh(ALT[S])(\alpha) \Leftrightarrow Exh(\alpha, \beta, \gamma)(\alpha)$
(ii) $\beta^+ \Leftrightarrow Exh(ALT[S])(\beta) \Leftrightarrow Exh(\alpha, \beta, \gamma)(\beta)$
(iii) $\gamma^+ \Leftrightarrow Exh(ALT[S])(\gamma) \Leftrightarrow Exh(\alpha, \beta, \gamma)(\gamma)$

The exhaustification routine continues until at least one of several specific stopping conditions is met. These conditions are provided in (77).

(77) **Conditions that prevent *Exh* from applying further:**
a. $Exh(ALT[S])(S) \Leftrightarrow S^+$ [*Exh* yields a stronger meaning and no ignorance left]
b. $Exh(ALT[S])(S) \Leftrightarrow S$ [*Exh* yields a similar meaning but no new alternatives]
c. $Exh(ALT[S])(S) \Leftrightarrow S^-$ [*Exh* yields a weaker meaning]
d. $Exh(ALT[S])(S) \Leftrightarrow \bot$ [*Exh* yields a contradiction]

The most natural endpoint of the whole operation occurs when the *Exh* parsing strategy can no longer apply because all ignorance has been resolved (77a). Moreover, there are three other

cases in which the procedure halts even though some ignorance persists. First, if the repeated application of *Exh* yields a meaning that is parallel to the input, the procedure may halt. In this case, what determines whether the procedure halts is whether new enriched alternatives have been derived during the previous round of exhaustification. If so, the procedure continues (one of such cases is presented in Section 3.3.2); if not, it halts (77b). Second, if applying *Exh* results in a meaning that is actually weaker than the prejacent, the procedure is blocked (77c). Third, if the procedure introduces a contradiction, the procedure is also blocked (77d).

Essentially, when the exhaustification routine halts, but the resulting statement still carries undesirable ignorance inferences, the latter inferences become unavoidable. Unavoidable ignorance inferences are ignorance inferences that cannot be resolved without jeopardising the consistency of the reasoning. This is the case, for instance, for simple disjunctive statements. Intuitively, simple disjunctive statements carry ignorance inferences that cannot be fully eliminated. The reason is that, after the first round of exhaustification, any further application of *Exh* would be vacuous, as in the case in (77b). To illustrate, let us first consider the status of the speaker's beliefs in (78) after the first round of exhaustification.

(78) a. **Primary belief:**
The speaker believes that Liz bought a croissant or a donut. $\Box_s(P \vee Q)$

b. **Ignorance inferences:**
$\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a croissant. $\neg\Box_s(P)$
$\rightsquigarrow$ It is not the case that the speaker believes that Liz bought a donut. $\neg\Box_s(Q)$

c. **Exclusivity inference:**
$\rightsquigarrow$ The speaker believes that it is not the case that Liz bought a croissant and a donut. $\Box_s\neg(P \wedge Q)$

According to (78), the speaker believes her utterance to be true (78a), is uncertain about which disjunct is true (78b), but is certain that the conjunctive alternative is false (78c). Once again, the ignorance inferences in (78b) are undesirable, as they conflict with the Maxim of Quality. Subsequently, the *Exh* parsing strategy applies and licenses a second round of exhaustification, as shown in (79). For clarity and to avoid clutter in the formulas, let us abbreviate the enriched simple disjunctive statement $(P \vee Q) \wedge \neg(P \wedge Q)$ as OR^+.

(79) a. Since OR^+ carries the ignorance inferences in (78b)
b. Parse OR^+ as $Exh(ALT(\text{OR}^+))(\text{OR}^+)$.

For the second round of exhaustification, OR^+ is the prejacent and $ALT(\text{OR}^+)$ is the set of alternatives to reason with. This set, given in (80), is composed of the exhaustified counterparts[17] of the alternatives of the previous round. Notice that the conjunctive alternative in (80c) can be ignored since it is already excluded within the prejacent and as such will not count toward the composition of the maximal subsets.

(80) **Set of alternatives for OR^+:**
$ALT(\text{OR}^+) = \{(P \vee Q) \wedge \neg(P \wedge Q), (P \wedge \neg Q), (Q \wedge \neg P), (P \wedge Q)\}$

a. **Prejacent:**
$Exh(ALT[P \vee Q])(P \vee Q) \Leftrightarrow (P \vee Q) \wedge \neg(P \wedge Q)$

b. **Individual disjuncts:**

[17] For each individual disjunct, the only innocently excludable alternative is the other disjunct. For the conjunctive alternative, there is no innocently excludable alternative as conjunction is already the strongest element on the scale.

(i) $Exh(ALT[P \vee Q])(P) \Leftrightarrow (P \wedge \neg Q)$
(ii) $Exh(ALT[P \vee Q])(Q) \Leftrightarrow (Q \wedge \neg P)$

c. **Conjunctive alternative:**
$Exh(ALT[P \vee Q])(P \wedge Q) \Leftrightarrow (P \wedge Q)$ *(can be ignored)*

The next step is to identify the maximal subsets and compute the set of innocently excludable alternatives. In a similar manner as for the first round of exhaustification, any set that includes the prejacent itself (81a) or both individual disjuncts (81b) would yield a contradiction, as illustrated in (82).

(81) **Non-maximal subsets of $ALT(\mathbf{OR}^+)$:**
a. $\{(P \vee Q) \wedge \neg(P \wedge Q)\}$ [yields a contradiction, (82a)]
b. $\{(P \wedge \neg Q),\ (Q \wedge \neg P)\}$ [yields a contradiction, (82b)]

(82) a. $\underbrace{[(P \vee Q) \wedge \neg(P \wedge Q)]}_{\text{Prejacent}} \wedge \underbrace{\neg[(P \vee Q) \wedge \neg(P \wedge Q)]}_{\text{Negating the prejacent}} \Leftrightarrow \bot$

b. $\underbrace{[(P \vee Q) \wedge \neg(P \wedge Q)]}_{\text{Prejacent}} \wedge \underbrace{\neg(P \wedge \neg Q) \wedge \neg(Q \wedge \neg P)}_{\text{Negating the individual disjuncts}} \Leftrightarrow \bot$

The only way to preserve the consistency of the reasoning is to negate the individual disjuncts separately, producing the maximal subsets in (83). However, since these subsets do not overlap, the set of innocently excludable alternatives is now empty, as shown in (84).

(83) **Maximal subsets of $ALT(\mathbf{OR}^+)$:**
a. $\{(P \wedge \neg Q)\}$
b. $\{(Q \wedge \neg P)\}$

(84) **Set of Innocently Excludable alternatives of $ALT(\mathbf{OR}^+)$:**
$ALT^{\text{IE}}(\text{OR}^+) = \{P \wedge \neg Q\} \cap \{Q \wedge \neg P\}$
$= \varnothing$

Therefore, the second round of exhaustification in (85) is vacuous because there is no innocently excludable alternative to negate. In this context, vacuous means that the application of the *Exh* operator does not strengthen the meaning of the sentence any further. It produces no new inferences and leaves the interpretation unchanged.

(85) $Exh(ALT(\text{OR}^+))(\text{OR}^+) \Leftrightarrow \underbrace{(P \vee Q) \wedge \neg(P \wedge Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\text{IE}}(\text{OR}^+))}_{\text{Negating IE Alternatives}}$
$\Leftrightarrow \underbrace{(P \vee Q) \wedge \neg(P \wedge Q)}_{\text{Prejacent}}$

Despite this, the twice-exhaustified disjunctive statement still carries ignorance inferences, which, according to the *Exh* parsing strategy, trigger a third round of exhaustification. However, a third hypothetical round would also be vacuous (as would be the fourth, the fifth, etc.). The reason is that the alternatives for any subsequent round after the first one are the same alternatives as for the second round.[18] Since the second round did not introduce any new

[18] The reason is that the individual disjuncts, $(P \wedge \neg Q)$ and $(Q \wedge \neg P)$, and the conjunctive alternative, $(P \wedge Q)$,

alternatives, the procedure halts. Consequently, ignorance inferences about the individual disjuncts cannot be cleared and are, thus, unavoidable.

3.3 Conjunctive strengthening of disjunction

Although the exhaustification procedure only leads to the exclusivity inference in the case of simple disjunction, this section demonstrates that a recursive exhaustification procedure can derive free choice inferences, and can also account for a range of empirical adult and child data in which simple disjunction is interpreted with the truth conditions of conjunction. This section serves as a comprehensive introduction for the formal account that will be developed in Chapter 3 and Chapter 5. Section 3.3.1 presents the derivation for free choice inferences under the grammatical approach. Sections 3.3.2 and 3.3.3 illustrate how certain assumptions about the relevant set of alternatives can lead to a conjunctive strengthening of disjunction in adult Warlpiri and in child language, respectively.

3.3.1 The derivation of the free choice inference

Take the modal disjunctive statement in (86). Recall from Section 2.4 that the traditional Gricean framework struggles to derive the free choice inference in (86b), although it naturally accounts for the exclusivity inference in (86c). In this section, we demonstrate below that the grammatical approach to scalar implicatures can successfully derive both inferences.

(86) Liz can buy a croissant or a donut.
   a. **Logical meaning:**
      Liz can buy a croissant or a donut, possibly both. $\Diamond(P \vee Q)$
   b. **Free Choice inference:**
      $\rightsquigarrow$ Liz can buy a croissant and Liz can buy a donut. $\Diamond P \wedge \Diamond Q$
   c. **Exclusivity inference:**
      $\rightsquigarrow$ Liz cannot buy both a croissant and a donut. $\neg\Diamond(P \wedge Q)$

The first step involves identifying the ignorance inferences that trigger the exhaustification procedure, according to the *Exh* parsing strategy. Upon hearing (86), the listener infers that it is not the case that the speaker believes that Liz can buy a croissant (87a), a donut (87b), or both (87c). As these ignorance inferences are undesirable as per the Maxim of Quality, the modal disjunctive statement in (86) can be parsed as (88).

(87) **Ignorance inferences for "*Liz can buy a croissant or a donut.*"**
   a. $\rightsquigarrow$ It is not the case that the speaker believes that Liz can buy a croissant. $\neg\Box_s(\Diamond C)$
   b. $\rightsquigarrow$ It is not the case that the speaker believes that Liz can buy a donut. $\neg\Box_s(\Diamond D)$
   c. $\rightsquigarrow$ It is not the case that the speaker believes that Liz can buy a croissant and a donut. $\neg\Box_s\Diamond(C \wedge D)$

(88) a. $Exh(ALT[\text{Liz can buy a croissant or a donut}])(\text{Liz can buy a croissant or a donut})$
   b. $Exh(ALT[\Diamond(P \vee Q)])(\Diamond[P \vee Q])$

The corresponding set of alternatives in (89) contains two maximal subsets, given in (90), whose members can be negated consistently with the prejacent. Like simple disjunction, the conjunctive alternative is the only alternative that is shared by both sets and, as such, is the only innocently excludable alternative (91).

are each true in a single scenario. In other words, they are already in their strongest form and can no longer be strengthened.

(89) **Set of alternatives for $\Diamond(P \vee Q)$:**
$ALT(P \vee Q) = \{\underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}}, \underbrace{\Diamond P, \Diamond Q}_{\substack{\text{Individual}\\\text{disjuncts}}}, \underbrace{\Diamond(P \wedge Q)}_{\substack{\text{Conjunctive}\\\text{alternative}}}\}$

(90) **Maximal subsets of $\Diamond(P \vee Q)$:**
a. $\{\Diamond P, \Diamond(P \wedge Q)\}$
b. $\{\Diamond Q, \Diamond(P \wedge Q)\}$

(91) **Set of Innocently Excludable alternatives of $\Diamond(P \vee Q)$:**
$ALT^{\text{IE}}(\Diamond[P \vee Q]) = \{\Diamond P, \Diamond(P \wedge Q)\} \cap \{\Diamond Q, \Diamond(P \wedge Q)\}$
$= \{\Diamond(P \wedge Q)\}$

Then, the exhaustification procedure applies: the conjunctive alternative is negated from the prejacent, yielding an enriched meaning, specifically, that Liz is given the possibility to buy a croissant or a donut ($\Diamond[P \vee Q]$), but not the possibility to buy both ($\neg\Diamond(P \wedge Q)$). The derivation is shown in (92). The resulting updated beliefs are summarised in (93).

(92) $Exh(ALT(\Diamond[P \vee Q]))(\Diamond[P \vee Q]) \Leftrightarrow \underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\text{IE}}(\Diamond[P \vee Q]))}_{\text{Negating IE Alternatives}}$
$\Leftrightarrow \underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg\Diamond(P \wedge Q)}_{\text{Exclusivity}}$

(93) a. **Primary belief:**
The speaker believes that Liz can buy a croissant or a donut. $\Box_s\Diamond(P \vee Q)$
b. **Ignorance inferences:**
$\rightsquigarrow$ It is not the case that the speaker believes that Liz can buy a croissant. $\neg\Box_s\Diamond(P)$
$\rightsquigarrow$ It is not the case that the speaker believes that Liz can buy a donut. $\neg\Box_s\Diamond(Q)$
c. **Exclusivity inference:**
The speaker believes that it is not the case that Liz can buy both a croissant and a donut. $\Box_s\neg\Diamond(P \wedge Q)$

Importantly, although this round of exhaustification yields an exclusivity inference (as in simple disjunction), it does not yet produce the desired free choice reading. However, since the statement still conveys ignorance as to whether Liz can buy each individual pastry (93b), the *Exh* parsing strategy re-applies, triggering a second round of exhaustification. Unlike in the case of simple disjunctive statements, this second round will not be vacuous, as is demonstrated below. Recall from the previous section that the set of alternatives for the second round of exhaustification is composed of the exhaustified counterparts of the alternatives of the first round. These alternatives are given in (94). As for the second round of exhaustification of simple disjunction (Section 3.2), the conjunctive alternative in (94c) can be ignored as it is already excluded by the prejacent. For clarity and to avoid clutter in the formulas, let us abbreviate the enriched modal disjunctive statement $\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)$ as $\Diamond\text{OR}^+$.

(94) **Set of alternatives for $\Diamond\mathbf{OR}^+$:**
$ALT(\Diamond\text{OR}^+) = \{\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q), (\Diamond P \wedge \neg\Diamond Q), (\Diamond Q \wedge \neg\Diamond P), \Diamond(P \wedge Q)\}$
a. **Prejacent:**
$Exh(ALT(\Diamond[P \vee Q]))(\Diamond[P \vee Q]) \Leftrightarrow \Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)$

b. **Individual disjuncts:**
   (i) $Exh(ALT(\Diamond[P \vee Q]))(\Diamond P) \Leftrightarrow (\Diamond P \wedge \neg\Diamond Q)$
   (ii) $Exh(ALT(\Diamond[P \vee Q]))(\Diamond Q) \Leftrightarrow (\Diamond Q \wedge \neg\Diamond P)$
c. **Conjunctive alternative:**
   $Exh(ALT(\Diamond[P \vee Q]))(\Diamond[P \wedge Q]) \Leftrightarrow \Diamond(P \wedge Q)$ *(can be ignored)*

The set in (94) has only one maximal subset consistent with the prejacent, given in (95), which includes the two enriched individual disjuncts. Any other subset of $ALT(\Diamond\text{OR}^+)$ either can be further enlarged or yields a contradiction with the prejacent, and therefore does not qualify as maximal.

(95) **Maximal subset of $ALT(\Diamond\mathbf{OR}^+)$:**
$\{(\Diamond P \wedge \neg\Diamond Q), (\Diamond Q \wedge \neg\Diamond P)\}$

(96) **Non-maximal subsets of $ALT(\Diamond\mathbf{OR}^+)$:**
a. $\{\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)\}$ [yields a contradiction]
b. $\{(\Diamond P \wedge \neg\Diamond Q)\}$ [can be enlarged]
c. $\{(\Diamond Q \wedge \neg\Diamond P)\}$ [can be enlarged]

Since there is only one such maximal subset, every element within this set is innocently excludable. The corresponding set is given in (97). The free choice interpretation naturally follows by negating these alternatives, as demonstrated in the derivation in (98).

(97) **Set of Innocently Excludable alternatives of $\Diamond(P \vee Q)$:**
$ALT^{\text{IE}}(\Diamond\text{OR}^+) = \{(\Diamond P \wedge \neg\Diamond Q), (\Diamond Q \wedge \neg\Diamond P)\}$

(98) $Exh(ALT(\Diamond\text{OR}^+))(\Diamond\text{OR}^+)$

$$\Leftrightarrow \underbrace{\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\text{IE}}(\Diamond\text{OR}^+))}_{\text{Negating IE Alternatives}}$$

$$\Leftrightarrow \underbrace{\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(\Diamond P \wedge \neg\Diamond Q)}_{\text{Not only } \Diamond P} \wedge \underbrace{\neg(\Diamond Q \wedge \neg\Diamond P)}_{\text{Not only } \Diamond Q}$$

$$\Leftrightarrow \underbrace{\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)}_{\text{Prejacent}} \wedge \underbrace{(\Diamond P \leftrightarrow \Diamond Q)}_{\substack{\text{Both possibilities} \\ \text{or neither}}}$$

$$\Leftrightarrow \underbrace{(\Diamond P \wedge \Diamond Q)}_{\text{Free Choice}} \wedge \underbrace{\neg\Diamond(P \wedge Q)}_{\text{Exclusivity}}$$

The sentence "*Liz can buy a croissant or a donut*", which underwent two rounds of exhaustification, now carries the following enriched meaning: (i) Liz has the possibility to buy the croissant or the donut ($\Diamond[C \vee D]$), (ii) but she cannot buy both together ($\neg\Diamond[C \wedge D]$), though (iii) she has the possibility to buy the croissant ($\Diamond C$), and (iv) she has the possibility to buy the donut ($\Diamond D$). In other words, Liz has the possibility to buy each individual pastry and is therefore free to choose between the two. This derivation successfully captures the desired free choice inference, while preserving the exclusivity inference established during the first round. Notice, moreover, that ignorance has been completely resolved and no further round of exhaustification is thus expected.

Notably, there is no contradiction between the free choice inference and the exclusivity

inference since the free choice interpretation ($\Diamond P \wedge \Diamond Q$) is not equivalent to the modal conjunctive alternative ($\Diamond[P \wedge Q]$), as shown in (99). Exclusion of the latter alternative has no consequences on the derivation of the free choice inference in the second round.

(99) a. $\Diamond(P \wedge Q) \Rightarrow (\Diamond P \wedge \Diamond Q)$
b. $(\Diamond P \wedge \Diamond Q) \not\Rightarrow \Diamond(P \wedge Q)$
c. Therefore $\Diamond(P \wedge Q) \not\Leftrightarrow (\Diamond P \wedge \Diamond Q)$

Importantly, the exclusivity and the free choice inferences differ in strength. As Simons (2005) points out, in modal disjunctive statements, the exclusivity inference appears to be optional whereas the free choice inference is robust and non-cancellable. For instance, consider the two possible continuations to a modal disjunctive statement in (100). Whereas the exclusivity inference is readily cancelled (100a), the free choice inference cannot be negated (100b).

(100) Liz can buy a croissant or a donut.
a. ✓ That's true! In fact, she can even buy both. [cancels Exclusivity]
b. × That's true! In fact, she can only buy a croissant. [cancels Free Choice]

To account for this difference, it has been argued that the distinction between these two inferences lies in the type of alternative involved (Chemla & Bott, 2014; Singh et al., 2016; Spector, 2014; Tieu et al., 2016; Zhou et al., 2013; Huang & Crain, 2020). Specifically, inferences relying on sub-domain alternatives, generated by decomposition of the disjunctive statement into sub-constituents, are argued to be mandatory and thus not cancellable. By contrast, inferences depending on scalar alternatives, arising through lexical replacement, are optional and hence cancellable.

This distinction will play a crucial role in Chapter 5, where we investigate how these two inferences are acquired. In particular, we show that, independently of the technical explanation, a majority of adults derive the exclusivity inference, whereas children typically do not. Moreover, we show that children also experience difficulties in calculating the free choice inference, suggesting that their problems extend beyond the scalar alternative (that is required to derive the exclusivity inference) and may reflect further specificity in how they compose meaning (e.g. by inserting the *Exh* operator as low in the structure as possible as will be argued in Chapter 5).

3.3.2 Conjunctive strengthening in adult Warlpiri

Recall from Section 3.2.2 that repeated applications of the exhaustification procedure are blocked in simple disjunctive statements in languages such as English and French. That is, once the initial exclusivity inference has been derived, any further round of exhaustification yields a contradiction, thereby halting the process. But, this observation is not true for every language. Bowler (2014) reports that Warlpiri permits a second round of exhaustification with simple disjunctive statements, resulting in a conjunctive interpretation. In order to make such a derivation possible, however, certain assumptions must be made regarding the composition of the set of alternatives to reason with. In this Section, we review the Warlpiri data and present the derivation and the associated assumptions that lead to the conjunctive strengthening of a simple disjunctive statement.

According to Bowler (2014), Warlpiri possess a single connective *manu* that receives the truth conditions of conjunction in upward-entailing contexts (e.g. such as in positive assertions), but behaves as an inclusive disjunction in downward entailing contexts (e.g., under

negation). To illustrate, compare (101) and (102).

(101) a. Cecilia manu Gloria=pala yanu tawunu-kurra.
Cecilia *manu* Gloria=3DU.SUBJ go.PST town-ALL
"Cecilia and Gloria went to town."
b. Jirrama=juku.
two=EXACTLY
"Exactly two did."

(102) a. Kula=rna yunparnu manu wurntija jalangu.
NEG=1SG.SUBJ sing.PST *manu* dance.PST today
"I did not sing or dance today."
b. Lawa.
nothing
"I did nothing."

In (101a), the connective *manu* appears in a positive assertion. Bowler reports that Warlpiri adult speakers interpret *manu* as a conjunction. She further notes that Warlpiri speakers readily accept (101b), which explicitly states that both conjuncts are true, as a successful paraphrase of (101a). In contrast, in (102a), where *manu* is embedded under the negative morpheme *kula*, Bowler reports that Warlpiri speakers interpret *manu* as if it were an inclusive disjunction, yielding the interpretation that neither disjunct is true, as reflected in the paraphrase in (102b). This interpretation is consistent with classical logical equivalences, such as De Morgan's laws (103), where the negation of a disjunctive statement is equivalent to the conjunction of two negated propositions (103a).

(103) **De Morgan's Laws:**
a. $\neg(P \vee Q) \Leftrightarrow (\neg P \wedge \neg Q)$
b. $\neg(P \wedge Q) \Leftrightarrow (\neg P \vee \neg Q)$

At first glance, it appears that *manu* is ambiguous between the disjunctive denotation in (104a) and the conjunctive denotation in (104b). In the case where *manu* receives the latter denotation, accounting for its conjunctive behaviour in positive assertions is trivial, as it is simply interpreted just like English *and*. Under negation, this would only require the assumption that *manu* is interpreted out of the scope of negation (e.g. *manu* > NEG; $\neg P \wedge \neg Q$).

(104) a. **Inclusive denotation for *manu*:**
$[\![manu]\!] \Leftrightarrow [\![or]\!] = \lambda u \in D_{<t>}.\lambda v \in D_{<t>}.u \vee v = 1$
b. **Conjunctive denotation for *manu*:**
$[\![manu]\!] \Leftrightarrow [\![and]\!] = \lambda u \in D_{<t>}.\lambda v \in D_{<t>}.u \wedge v = 1$

However, a conjunctive denotation for *manu* fails to account for its disjunctive behavior in other downward-entailing contexts such as in the antecedent of conditionals (105) or in Wh-questions (106). In both cases, *manu* is interpreted inclusively, allowing for at least one disjunct to be true. Recall from Section 1.1 that embedding a disjunctive expression in the antecedent of a conditional statement was similarly used to argue in favor of an inclusive disjunctive denotation for disjunction, a line of reasoning also adopted by Su and Crain (2010) and Su (2014) to support the claim that children do not confuse the lexical items for disjunction and conjunction.

(105) a. Kaji=npa jarntu pakarni manu window luwarni,
IRR=2SG.SUBJ dog hit.NPST *manu* window shoot.NPST
"If you hit the dog or/and break the window..."
b. ngula=ju Nungarrayi-rli kapi=ngki jirna-wangu-mani
that=TOP Nungarrayi-ERG AUX.FUT=2SG.NSUBJ scold.NPST
"Then Nungarrayi will scold you."

(106) Ngana-ngku ka mardarni ngaya manu jarntu?
who-ERG AUX have.NPST cat *manu* dog
"Who has a cat or/and a dog?"

Bowler thus concludes that *manu* denotes an inclusive disjunction. However, this position naturally raises a question: how does the conjunctive reading emerge in upward-entailing contexts? Bowler (2014) proposes that this reading is derived through recursive exhaustification, by means of a derivation similar to the calculation of the free choice inference in modal disjunction (107a). Yet, as recalled from Section 3.2, unlike modal disjunction, repeated applications of the exhaustification procedure to simple disjunctive statements yield a vacuous result, identical to the output of the first round (107b).

(107) a. **Warlpiri:** $Exh(Exh(P\ manu\ Q)) \Leftrightarrow (P \wedge Q)$
b. **English:** $Exh(Exh(P\ or\ Q)) \Leftrightarrow (P \vee Q) \wedge \neg(P \wedge Q)$

To address this discrepancy, Bowler (2014) argues that *manu* differs from English *or* in that it lacks the scalar conjunctive alternative $(P \wedge Q)$ from the set of alternatives under consideration. To illustrate, compare the alternatives for English *or* (108a) with those Bowler proposes for Warlpiri *manu* (108a).

(108) a. Set of alternatives for English $(P\ or\ Q) = \{(P \vee Q), P, Q, (P \wedge Q)\}$
b. Set of alternatives for Warlpiri $(P\ manu\ Q) = \{(P \vee Q), P, Q\}$

For Bowler, the absence of the conjunctive alternative from the set in (108b) follows from the fact that Warlpiri lacks an overt conjunctive lexical item corresponding to the English conjunction *and*. Thus, according to the algorithm for generating alternatives outlined in Section 3.1 (Fox & Katzir, 2011; Katzir, 2007), the lexical replacement operation, where scalar items are replaced by members of their Horn scale, returns no alternative since there is nothing for *manu* to be substituted with. As will be shown below, the absence of the conjunctive alternative is the cornerstone of the entire reasoning, as it allows for the conjunctive strengthening of disjunction to the meaning of conjunction.

In what follows, we provide the complete exhaustification procedure of *manu*, as was proposed by Bowler (2014). In the case of English *or*, the conjunctive alternative $(P \wedge Q)$ was the only innocently excludable alternative. In contrast, for Warlpiri *manu*, no such alternative is available in the first round of exhaustification. Consider the two maximal subsets of $(P\ manu\ Q)$ in (109). Each of these maximal subsets includes one of the two disjuncts and, crucially, there is no additional subset, such as those in (110), that can be consistently excluded with the prejacent.

(109) **Maximal subsets of** $ALT(P\ \boldsymbol{manu}\ Q)$
a. $\{P\}$
b. $\{Q\}$

(110) **Non-maximal subsets of** $ALT(P$ ***manu*** $Q)$
a. $\{(P \vee Q)\}$ [yields a contradiction, (111a)]
b. $\{P, Q\}$ [yields a contradiction, (111b)]

(111) a. $(P \vee Q) \wedge \neg(P \vee Q) \Leftrightarrow \bot$
b. $(P \vee Q) \wedge \neg P \wedge \neg Q \Leftrightarrow \bot$

Since these maximal subsets are disjoint, no innocently excludable alternative is available for negation, yielding the empty set in (112), and resulting in a vacuous first round of exhaustification in (113); that is, the output meaning remains unchanged.

(112) **Set of innocently excludable alternatives of** $(P$ ***manu*** $Q)$**:**
$ALT^{\text{IE}}(P\ manu\ Q) = \{P\} \cap \{Q\}$
$= \varnothing$

(113) $Exh(ALT(P\ manu\ Q))(P\ manu\ Q) \Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\text{IE}}(P\ manu\ Q))}_{\text{Negating IE Alternatives}}$
$\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}}$

The next step is straightforwardly parallel to the derivation of the free choice inference. As ignorance about the individual disjuncts has not been cleared, a second round of exhaustification is in principle licensed. Although the first round did not produce an enriched output meaning, it still provided exhaustified alternatives to be employed in the second round. These alternatives are listed in (114). Notice the superscript plus in $(P\ manu\ Q)^+$ which indicates that the statement already underwent one round of exhaustification.

(114) **Set of alternatives for** $(P$ ***manu*** $Q)^+$**:**
$ALT([P\ manu\ Q]^+) = \{(P \vee Q), (P \wedge \neg Q), (Q \wedge \neg P)\}$
a. **Prejacent:**
$Exh(ALT[P\ manu\ Q])(P\ manu\ Q) \Leftrightarrow (P \vee Q)$
b. **Individual disjuncts:**
(i) $Exh(ALT[P\ manu\ Q])(P) \Leftrightarrow (P \wedge \neg Q)$
(ii) $Exh(ALT[P\ manu\ Q])(Q) \Leftrightarrow (Q \wedge \neg P)$

The set in (114) has only one maximal subset, consisting of both enriched individual disjuncts. Any other subset of $ALT([P\ manu\ Q^+])$ would be inconsistent with the prejacent or could have been enlarged.

(115) **Maximal subset of** $ALT([P$ ***manu*** $Q^+])$**:**
$\{(P \wedge \neg Q), (Q \wedge \neg P)\}$

(116) **Non-maximal subsets of** $ALT([P$ ***manu*** $Q^+])$**:**
a. $\{(P \vee Q)\}$ [yields a contradiction]
b. $\{(P \wedge \neg Q)\}$ [can be enlarged]
c. $\{(Q \wedge \neg P)\}$ [can be enlarged]

As there is only one maximal subset, each of its members belongs to the set of innocently excludable alternatives given in (117). As is demonstrated by the derivation in (118), negating

the enriched individual disjuncts yields the conjunctive interpretation we were aiming for.[19]

(117) **Set of innocently excludable alternatives of $(P$ *manu* $Q)^+$:**
$ALT^{\text{IE}}([P \textit{ manu } Q]^+) = \{(P \wedge \neg Q), (Q \wedge \neg P)\}$

(118) $Exh(ALT([P \textit{ manu } Q]^+))([P \textit{ manu } Q]^+) \Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\text{IE}}([P \textit{ manu } Q]^+))}_{\text{Negating IE Alternatives}}$

$\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(P \wedge \neg Q)}_{\text{Not only P}} \wedge \underbrace{\neg(Q \wedge \neg P)}_{\text{Not only Q}}$

$\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{(P \leftrightarrow Q)}_{\text{Both true or both false}}$

$\Leftrightarrow \underbrace{(P \wedge Q)}_{\text{Conjunctive Inference}}$

Since each alternative of $ALT(P$ *manu* $Q)$ has been either assigned true or false, ignorance has been completely resolved. As a consequence, the *Exh* parsing strategy no longer applies and the exhaustification procedure halts.

All in all, when the conjunctive alternative is not generated, as for Walrpiri *manu*, the exhaustification procedure results in a conjunctive strengthening of disjunction. This derivation is particularly relevant for language acquisition, as the absence of the conjunctive alternative also plays a crucial role in explaining non-adult-like conjunctive interpretations, as will be shown in the next section.

3.3.3 Conjunctive strengthening in the child grammar

Conjunctive interpretations of simple disjunctive statements are also attested in children. Several studies have reported that learners of age four to five often interpret disjunction with the truth conditions of conjunction (Braine & Rumain, 1981; Paris, 1973; Singh et al., 2016; Tieu et al., 2017; as well as Chapters 3 and 5 of this book). To account for this non-adult-like behaviour, Singh et al. (2016) assumes that children have acquired the exhaustification procedure but cannot generate the complete set of alternatives to reason with. Specifically, building on earlier findings from Barner and Bachrach (2010) and Barner et al. (2011), among others, that children face difficulties in generating alternatives that require lexical substitution, Singh et al. (2016) proposed that conjunctive interpreters lack the conjunctive alternative in the set of alternatives of simple disjunction. As illustrated in (119), the set of alternatives available to children for simple disjunction (119b) is a subset of the adult set (119a) and is comparable to Warlpiri *manu* (119c).

[19] Importantly, unlike in modal disjunctive statements, if the exclusivity inference were derived in a simple disjunctive statement, negating both enriched individual disjuncts would generate a contradiction with the previously derived inference. This difference follows from a structural property often referred to as closure under conjunction. A set of alternatives is said to be closed under an operation if applying that operation to certain members of the set yields another member of the same set. The set of alternatives for simple disjunction is closed under conjunction because the conjunction of the two individual disjuncts $(P \wedge Q)$ is part of $ALT(P \vee Q)$. By contrast, the set of alternatives for modal disjunction is not closed under conjunction because the conjunction of the two modal individual disjuncts (i.e., the free choice inference, $\Diamond P \wedge \Diamond Q$) is not a member of $ALT(\Diamond[P \vee Q])$. This explains why exhaustifying a modal disjunctive statement does not create a contradiction between the free choice and the exclusivity inferences.

(119) a. $ALT_{\text{Adult}}(P \vee Q) = \{(P \vee Q), P, Q, (P \wedge Q)\}$
b. $ALT_{\text{Child}}(P \vee Q) = \{(P \vee Q), P, Q\}$
c. $ALT(P\ manu\ Q) = \{(P \vee Q), P, Q\}$

The subsequent exhaustification procedure is strictly parallel to the conjunctive strengthening of Warlpiri *manu* introduced in the previous section. No maximal subset can be excluded consistently with the prejacent (120) and, thus, no innocently excludable alternative (121).

(120) **Maximal subsets of $ALT_{\textbf{Children}}(P \vee Q)$:**
a. (P)
b. (Q)

(121) **Set of innocently excludable alternatives of child $(P \vee Q)$:**
$ALT^{\text{IE}}_{\text{Child}}(P \vee Q) = \{P\} \cap \{Q\}$
$= \varnothing$

Consequently, the first round of exhaustification, triggered by formerly derived ignorance inferences about the individual disjuncts, returns no enriched output meaning, as demonstrated by the derivation in (122).

(122) $$Exh(ALT_{\text{Child}}(P \vee Q))(P \vee Q) \Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\text{IE}}_{\text{Child}}(P \vee Q))}_{\text{Negating IE Alternatives}}$$
$$\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}}$$

Since ignorance has not been cleared entirely,[20] a second round of exhaustification is licensed. The enriched alternatives for the second round are listed in (123). Notice the superscript plus sign in $(P \vee Q)^+$ which indicates that the statement already underwent a round of exhaustification.

(123) **Alternatives for the second round of exhaustification of child $(P \vee Q)$:**
$ALT_{\text{Child}}([P \vee Q]^+) = \{(P \vee Q), (P \wedge \neg Q), (Q \wedge \neg P)\}$
a. $Exh(ALT_{\text{Child}}(P \vee Q))(P \vee Q) \Leftrightarrow (P \vee Q)$
b. $Exh(ALT_{\text{Child}}(P \vee Q))(P) \Leftrightarrow (P \wedge \neg Q)$
c. $Exh(ALT_{\text{Child}}(P \vee Q))(Q) \Leftrightarrow (Q \wedge \neg P)$

This set of alternatives returns only one maximal subset, given in (124). Any other subset would be non-maximal, e.g. (125), because either it would yield a contradiction or it could have been enlarged. The set of innocently excludable alternatives in (126) is, thus, composed of each of the members of (124), that is, the enriched individual disjuncts.

(124) **Maximal subset of $ALT_{\textbf{Child}}([P \vee Q]^+)$:**
$\{(P \wedge \neg Q), (Q \wedge \neg P)\}$

[20] Here, the relevant ignorance inferences concern the individual disjuncts. However, ignorance about the conjunctive scenario is also technically derived since $\neg\Box_s(P \wedge Q)$ logically follows from ignorance about the individual disjuncts, $\neg\Box_s(P)$ and $\neg\Box_s(Q)$. Yet, in Bowler (2014) and Singh et al. (2016), it is not clear whether lacking the conjunctive alternative also means that the corresponding ignorance inference is irrelevant and, thus, ignored by the *Exh* parsing strategy.

(125) **Non-maximal subsets of $ALT_{\textbf{Child}}([P \vee Q]^+)$:**
a. $\{(P \vee Q)\}$ [yields a contradiction]
b. $\{(P \wedge \neg Q)\}$ [can be enlarged]
c. $\{(Q \wedge \neg P)\}$ [can be enlarged]

(126) **Set of innocently excludable alternatives of child $(P \vee Q)^+$:**
$ALT^{\text{IE}}_{\text{Child}}(P \vee Q)^+ = \{(P \wedge \neg Q), (Q \wedge \neg P)\}$

The resulting derivation is given in (127). By negating the enriched individual disjuncts, a conjunctive interpretation of a simple disjunctive statement emerges naturally.

(127)
$$Exh(ALT_{\text{Child}}([P \vee Q]^+))([P \vee Q]^+) \Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\text{IE}}_{\text{Child}}([P \vee Q]^+))}_{\text{Negating IE Alternatives}}$$
$$\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(P \wedge \neg Q)}_{\text{Not only P}} \wedge \underbrace{\neg(Q \wedge \neg P)}_{\text{Not only Q}}$$
$$\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{(P \leftrightarrow Q)}_{\text{Both true or both false}}$$
$$\Leftrightarrow \underbrace{(P \wedge Q)}_{\text{Conjunctive inference}}$$

Since ignorance has been completely resolved, the *Exh* parsing strategy does no longer apply and the exhaustification procedure halts. For a more detailed discussion about the reasons why children would lack the conjunctive alternative and apply the exhaustification procedure twice, see Chapter 3 and Chapter 5.

To summarise, children often exhibit conjunctive interpretations of disjunction. This pattern has been documented in simple disjunctive statements across many languages, including English (Braine & Rumain, 1981; Paris, 1973; Singh et al., 2016), Japanese (Tieu et al., 2017), Romanian (Bleotu et al., 2023), and French (Cochard et al., 2023; Tieu et al., 2017; Chapter 3). As will be shown in the following chapters, this generalisation extends beyond simple disjunction to negated disjunction (Chapter 3) and modal disjunction (Chapter 5). Independently of these empirical generalisations, the grammatical approach to scalar implicatures provides the tools to characterise children's non-adult-like grammars by locating the source of their reasoning patterns in the compositional system rather than in a general inability to compute enriched meanings. Specifically, following Singh et al. (2016), children's errors can be traced back to difficulties in generating alternatives that require lexical replacement. Moreover, as sketched in Chapter 3 and developed in Chapter 5, we propose that children show a tendency to resolve ignorance as early as possible in the syntactic structure.

4 Challenges in testing disjunction

In previous sections, we modestly covered part of the vast literature on the mechanisms that can derive the many inferences of disjunction. Before moving to the next chapters of this book, we address some of the challenges that arise from the theoretical presentation made earlier. Specifically, in Section 4.1 we address the case of ignorance inferences and in Section 4.2 we discuss verifying and falsifying conditions of disjunction. Finally, Section 4.3 briefly discusses the morphosyntax of disjunction.

4.1 Satisfying ignorance inferences

A key challenge in testing disjunction is ensuring that the use of a disjunctive statement is felicitous. In recent years, many concerns have arisen regarding how such statements should be presented in experimental settings. In this section, we review one critical condition for the felicitous use of disjunction: ignorance.

As a starting point, recall from Section 2.1 that disjunction carries specific inferences about the speaker's belief states, namely, ignorance inferences. Arising from the straightforward application of the Gricean maxims, these inferences, given in (128), state that the speaker is uncertain about which disjunct is true.

(128) Liz bought a croissant or a donut.
   a. It is not the case that the speaker believes that Liz bought a croissant. $\neg\Box_s(P)$
   b. It is not the case that the speaker believes that Liz bought a donut. $\neg\Box_s(Q)$

Now consider two contexts, one that supports the ignorance inference, as in (129), and one that falsifies it, as in (130). In (129), the speaker who utters the disjunctive statement is genuinely ignorant of which pastry Liz bought. A key aspect of this context is that neither the speaker nor the listener witnessed the event in question. In contrast, in (130), the mutual friend did witness the event and therefore cannot be ignorant about what Liz bought.

(129) **Context satisfying ignorance inferences:**
Liz went to the bakery, alone. She sent our mutual friend a message saying she might buy a pastry, though she did not tell them which one. When I asked our mutual friend about it, they replied: "Liz bought a croissant or a donut."

(130) **Context not satisfying ignorance inferences:**
Liz and our mutual friend went to the bakery together. While waiting for them, I received a message saying they bought a pastry. Specifically, our mutual friend wrote: "Liz bought a croissant or a donut."

In previous experimental studies, ignorance inferences were inconsistently satisfied. For instance, Singh et al. (2016) used a truth-value judgment task in picture verification mode (Crain & Thornton, 1998) to test the interpretation of disjunctive statements, both in plain matrix sentences and in the nuclear scope of a universal quantifier in English. Children were shown static images of an event (e.g., a boy holding an apple and a banana) and heard a puppet describe it. The puppet made a disjunctive guess (e.g., "The boy is holding an apple or a banana"), and children were prompted to judge whether the description was right or wrong. Crucially, in this setup, the puppet uttering the test sentence was not ignorant. In contrast, Tieu et al. (2017) employed a truth-value judgment task in prediction mode (Crain & Thornton, 1998) to test the interpretation of simple and complex disjunctive statements in French (*ou* "or" vs. *soit...soit...* "either...or...") and Japanese (*ka* "or" vs. *ka...ka...* "either...or..."). In their experimental setup, children listened to a story involving characters performing various actions (e.g., a hen pushing objects down a hill). Before the action was carried out, a puppet intervened and made a disjunctive guess about what the character did. After the action unfolded, children were asked to judge whether the puppet's guess was good or bad. In this case, the puppet was ignorant.

Thus, while ignorance inferences were satisfied in Tieu et al. (2017), they were not in Singh et al. (2016). As pointed out by one of Singh et al.'s reviewers and by subsequent studies, their experimental setup may have biased children toward answering the wrong Question under

Discussion (e.g. did the character interact with both objects mentioned in the disjunctive statement?). Importantly, a recent study by Marty and Nicolae (2021) demonstrated that failure to satisfy ignorance inferences can have serious consequences for interpretation. When adults were confronted with disjunctive statements in contexts where ignorance was deliberately neutralised, some of them interpreted disjunction conjunctively. These results raised concerns about whether the conjunctive interpretations observed in children were truly non-adult-like, or simply methodological artefacts from the experimental design.

In Chapter 3, however, we show that children still showed conjunctive interpretations even when ignorance inferences were satisfied. In Chapter 6, we discuss more extensively the consequences of satisfying ignorance at all costs in the studies presented in this book.

4.2 Verifying and falsifying conditions

For a disjunctive statement to be informative, it must meet specific verifying and falsifying conditions. Consider the disjunctive statement in (131), which is typically tested in four types of scenarios in experimental setups. Whether a scenario verifies or falsifies the statement depends on the interpretation assigned to disjunction. Table 3 summarises the verification and falsification patterns for each interpretation. Under the literal inclusive interpretation, the statement is verified whenever at least one disjunct is true and falsified only when both are false. Under an exclusive interpretation, however, the sentence is verified only when exactly one disjunct is true. Finally, under a conjunctive interpretation, the statement is verified only when both disjuncts are true.

(131) Liz baked a croissant or a donut.

Scenario	**Interpretation**		
	Inclusive	**Exclusive**	**Conjunctive**
Liz baked both pastries.	✓	×	✓
Liz baked a croissant.	✓	✓	×
Liz baked a donut.	✓	✓	×
Liz did not bake anything.	×	×	×

Table 3: Verifying and falsifying scenarios for each interpretation of a simple disjunctive statement. ✓ indicates a verifying scenario. × indicates a falsifying scenario.

For a disjunctive statement to be felicitous, it must be uttered in a context that supports the verifying and falsifying scenarios described in Table 3. Assuming that the speaker adheres to the Cooperative Principle (see Section 2), uttering a disjunctive statement in an experimental setup that does not incorporate the appropriate scenarios results in pragmatic infelicity. For instance, hearing (131) in an experimental setup where it is already known that Liz did not bake anything, as in (132), would lead to the inference that the speaker is either lying or lacks sufficient evidence to revise their utterance into a more informative one. In other words, the speaker is, in fact, completely ignorant of what Liz baked.. The reason is that the only scenario that is compatible with the context in (132) is the scenario that falsifies disjunction.

(132) **No verifier context for (131):**
"Liz does not have enough ingredients to bake a croissant and a donut."
a. **Verifying scenarios:** ∅

b. **Falsifying scenarios:** {Liz did not bake anything}

In contrast, hearing (131) in a context where disjunction cannot be proven false is pragmatically odd as it contributes little to no information (that is new) in the conversation. Take (133) and (134) as two such contexts where uttering a disjunctive statement is not informative.

(133) **Non-informative context for (131):**
"Liz has enough ingredients to bake only one pastry, and she did bake one."
a. **Verifying scenarios:** {Liz baked a croissant, Liz baked a donut}
b. **Falsifying scenarios:** ∅

(134) **Always true context for (131):**
"Liz has enough ingredients to bake a croissant and a donut. She did bake one, maybe two."
a. **Verifying scenarios:** {Liz baked a croissant, Liz baked a donut, Liz baked both}
b. **Falsifying scenarios:** ∅

In (133), the truth of one disjunct necessarily entails the falsity of the other, leaving no plausible situation in which both disjuncts can be proven false. Consequently, the disjunctive statement becomes trivial, since it conveys no more than the assertion that Liz baked something, without specifying what. In other words, if the speaker had a firm belief about the truth of one or the other disjunct, she would have stated it explicitly (e.g. "Liz baked a croissant"). The choice of a disjunctive statement therefore suggests she is indifferent to whether Liz baked a croissant or a donut.

The same logic applies to (134). Although a disjunctive statement may appear more felicitous in such a context, since it permits the calculation of an exclusivity inference, the absence of a plausible falsifying scenario remains problematic, especially for acquisition. For instance, Skordos et al. (2020) raised concerns about experimental setups where disjunction could not successfully be falsified. Specifically, Skordos et al. point out that Tieu et al.'s (2017) design consistently presented children with a character that always acted positively toward at least one disjunct; for instance, a hen always pushed at least one of her two toys down a hill. In such a setup, the disjunctive statement can only ever be verified, as the possibility of not acting on either disjunct is never made salient.[21] Following Crain et al. (1996), Skordos et al. argue that when children are presented with a statement that cannot be proven false, they may evaluate it with respect to different criteria, such as an alternative Question under Discussion (QuD). Thus, in the case of disjunction, the intended QuD in (135a) might have been reinterpreted as (135b) or even as (135c). For instance, an inclusively interpreted disjunction would appropriately answer (135b), as this question only concerns whether at least one disjunct is true. Similarly, a conjunctively interpreted disjunction would constitute an appropriate answer to (135c), which specifically asks whether both disjuncts have been acted upon.

(135) a. What did Liz bake?
b. Did Liz bake something?
c. Did Liz act upon both mentioned pastries?

[21] Note that Tieu et al. (2017) had a condition in which the hen pushed neither of the two disjuncts. Instead the hen pushed a third object that was present in the context. However, this possibility to act on a third object only existed for this condition and did not appear in the conditions where either one or two disjuncts were true.

To utter a fully felicitous disjunctive statement, the context of utterance must include a plausible falsifying scenario. Two such contexts are illustrated in (136) and (137).

(136) **Plausible falsifier context for (131):**
"Liz has enough ingredients to bake a croissant and a donut, but she is not a good chef and might waste all of her ingredients and end up baking neither."
a. **Verifying scenarios:** {Liz baked a croissant, Liz baked a donut, Liz baked both}
b. **Falsifying scenarios:** {Liz did not bake anything.}

(137) **Three-alternative falsifier context for (131):** (Skordos et al., 2020)
"Liz has enough ingredients to bake a croissant or a donut, but she can also prepare a chocolate eclair with it."
a. **Verifying scenarios:** {Liz baked a croissant, Liz baked a donut, Liz baked both}
b. **Falsifying scenarios:** {Liz baked a chocolate eclair, Liz did not bake anything}

In both contexts, a scenario where neither disjunct is true is made plausible. In (136), this is achieved by explicitly allowing Liz to fail at baking pastries, whereas in (137), a third contextual alternative is introduced, giving Liz the option to bake something other than a croissant and a donut. Skordos et al. (2020) argue that the latter type of context is preferable, as it significantly reduces children's conjunctive interpretations of disjunction. However, contexts involving more than two alternatives also allow for additional ad-hoc implicatures (e.g., "Liz did not bake a chocolate eclair"), which may increase the complexity of the reasoning by encouraging the hearer to calculate more inferences. See the method section of Chapter 3 for a detailed discussion of which type of context is preferable and why our study adopted the plausible falsifier context in (136).

4.3 The morphosyntax of disjunction

In this section, we briefly discuss the morphosyntax of disjunction, including its different forms and how it is inserted into the syntactic structure. This discussion is relevant because the morphosyntax of disjunction has critical implications for its interpretation, and, consequently, for acquisition. We address the questions of morphosyntactic variation and the underlying syntactic structure in turn.

Disjunction can be expressed in different morphosyntactic forms, but its simple, non-reiterated form (e.g., 137) has been the most widely investigated in acquisition studies. Some studies, however, have examined complex reiterated forms of disjunction such as French *soit...soit...* ("either...or"), revealing important insights on children's performance with disjunction. One such study was carried out by Tieu et al. (2017), who investigated French disjunction both in its simple form (138; *ou*, "or") and in its complex form (139; *soit...soit...*, "either. . . or").

(138) Liz a pâtissé un croissant ou un donut.
Liz AUX.3SG.PRS bake.PART.PST a croissant or a donut
"Liz baked a croissant or a donut."

(139) Liz a pâtissé soit un croissant soit un donut.
Liz AUX.3SG.PRS bake.PART.PST SOIT a croissant SOIT a donut
"Liz baked either a croissant or a donut."

According to Tieu and colleagues, examining complex disjunction was motivated by the

empirical observation that, while (138) allows for the derivation of an exclusivity inference that can be later cancelled, a complex disjunctive statement like (139) appears to necessarily trigger such an inference and cannot be as easily cancelled as for its simple counterpart, as shown in (140; Spector, 2014), repeated from Section 1.3. To account for this discrepancy, Spector (2014) stipulates that in complex disjunction, the enrichment procedure is mandatory and cannot be cancelled.[22]

(140) a. Tous mes étudiants étudient soit l'allemand soit l'anglais.
All my students study.3PL.PRS soit the.german soit the.english
"Every student of mine studies either German or English."

b. Absolument ! Et certains étudient même les deux.
absolutely! and some study.3PL.PRS even the two
"Absolutely! And they even study both."

Because complex disjunctions trigger implicatures more robustly, the choice of disjunctive form is crucial, especially in acquisition. If, following Singh et al. (2016), we assume that children can produce enriched meanings (e.g., via exhaustification) but differ from adults in how they compute them, then children should treat simple and complex disjunctions similarly, exhibiting comparable non-adult-like readings. This prediction is confirmed by Tieu et al. (2017) and Bleotu et al. (2023), who report that children show non-adult-like conjunctive interpretations for both simple and complex disjunctions.

In this study, however, we focus exclusively on the simple form of French disjunction, *ou* "or".[23] This choice allows for direct comparison with the existing acquisition literature, but this is also because we will be concerned with testing disjunction embedded under negation and under a possibility modal, two environments that already come with their own package of problems when combined with the simple form of disjunction.

Let us turn now to the underlying syntax of disjunction, which plays a crucial role in determining its interpretation, especially when interacting with other operators such as negation.

[22] While Spector's (2014) claim initially concerns French *soit...soit...*, Szabolcsi (2015) extends this claim to other disjunctive statements involving reiterated particles such as Japanese *ka...ka...*, Russian *ili...ili...* and French *ou...ou...*, among many other languages.

[23] French simple disjunction *ou* "or" comes with the variant in (i), *ou bien* "or well", which, according to the author's French native speaker intuitions, appears to be slightly more exclusive, although not mandatorily exclusive as *soit...soit...*. For instance, in a conversation, (i) can be followed by (ii) which cancels the exclusivity inference. This suggests that *ou bien* receives a basic inclusive meaning that is then strengthened to an exclusive one.

(i) Liz a pâtissé un croissant ou bien un donut.
Liz aux.3sg.prs bake.PART.PST a croissant or well a donut
Liz baked a croissant or a donut.

(ii) Tout à fait. Elle a même fait les deux.
all at done she AUX even do.PART.PST DEF.PL two
"Absolutely. She even did both."

Interestingly, *ou bien* is also used in colloquial French in polar questions to signal the negative counterpart as shown in (iii). To our knowledge, there is no specific work focusing on *ou bien* except Nicolae et al. (2024) who tested the reiterated version *ou bien...ou bien...* and found that it is basically inclusive.

(iii) Tu viens, ou bien ?
You come.2sg.prs or well
Lit. "Are you coming, or well?"
Are you coming, or not?

Syntactically, disjunction can function either as a phrasal coordinator (linking NPs or VPs) or as a clausal connective (linking full propositions). While this distinction is mostly harmless in simple disjunctive statements, as in (141), it becomes crucial under negation, as illustrated in (142).[24]

(141) Liz bought a croissant or a donut.
  a. Liz bought [a croissant or a donut]. *Phrasal disjunction*
  b. [Liz bought a croissant] or [Liz bought a donut]. *Clausal disjunction*

(142) Liz did not buy a croissant or a donut.
  a. Liz did not buy [a croissant or a donut]. *Phrasal disjunction*
     $\Rightarrow (\neg P \wedge \neg Q)$ ("Liz bought neither of the two pastries")
  b. [Liz did not buy a croissant] or [she did not buy a donut.] *Clausal disjunction*
     $\Rightarrow (\neg P \vee \neg Q)$ ("Liz did not buy at least one of the two pastries")

The contrast in (142) demonstrates why this distinction is crucial. Under a phrasal analysis, negation takes wide scope over the entire disjunctive phrase, yielding a negative conjunctive interpretation ("neither P nor Q"). Under a clausal analysis, however, disjunction connects two negated propositions, resulting in a weaker, negative disjunctive interpretation ("not P or not Q").

This issue will play a central role in the present book, particularly in Chapter 4, where we experimentally tested negated disjunction with different prosodic variants. A key question is whether prosody only reflects scope (i.e., prosodic phrasing marking wide vs narrow scope) or whether it reveals deeper differences in underlying syntactic structure (i.e., whether the disjunction is phrasal or clausal). As discussed in Chapters 3 and 6, establishing this distinction is crucial for interpreting children's performance with negated disjunction.

5 Concluding remarks: Motivating the grammatical approach

Previous studies have identified three main patterns in children's interpretations of simple disjunctive statements. Some children exhibit the adult-like exclusive interpretation, accepting the statement only when exactly one of the two disjuncts is true (143a). Others show non-adult-like behaviour, either interpreting disjunction inclusively, accepting it whenever at least one disjunct is true (143b), or a conjunctive interpretation, accepting disjunctive statements only when both disjuncts are true (143c).

(143) Liz baked a croissant or a donut.
  a. **Exclusive:** Liz baked either a croissant or a donut.
  b. **Inclusive:** Liz baked a croissant or a donut, possibly both.
  c. **Conjunctive:** Liz baked a croissant and a donut.

These non-adult-like interpretations of disjunction have sparked significant interest in the literature on scalar implicatures, though they have not always been uniformly analysed. For a

[24] But it is critical for conjunction. Take (i) as an illustration. If the underlying syntax of (i) is the one of a phrasal conjunction, then it is expected to circle only the forms that are both black and small. To the contrary, if it is a clausal conjunction, then it should be allowed to circle forms that are both black and small, but also forms that are both black and big, and forms that are both small and non-black.

(i) Circle the forms that are black and small.
  a. Circle the forms that are [black and small]. *Phrasal conjunction*
  b. [Circle the forms that are black] and [circle the forms that are small]. *Clausal conjunction*

long time, explanations of children's non-adult-like behaviour with scalar implicatures were relatively limited. For instance, most studies reported that children were not computing the pragmatic enrichment that gives rise to the exclusivity inference (Chierchia et al., 2001a; Noveck, 2001; Guasti et al., 2005; Gualmini et al., 2001), often invoking the processing cost associated with such reasoning.

Over the past two decades, however, both experimental and theoretical advances have significantly improved our understanding of children's non-adult-like interpretations. Experimentally, more refined methodologies have emerged, distinguishing between inclusive and conjunctive interpretations (Tieu et al., 2017; Singh et al., 2016) and identifying the felicity conditions for disjunctive statements (Skordos & Papafragou, 2016; Skordos et al., 2020). Moreover, the development of the grammatical approach to scalar implicatures (Kratzer & Shimoyama, 2002; Fox, 2007; Chierchia et al., 2011; Bar-Lev & Fox, 2020), which models the phenomenon at the compositional level (rather than as post-compositional pragmatic reasoning), has expanded the tools available to account for developmental data, leading to a more fine-grained view of children's pragmatic abilities.

Under the traditional Gricean approach to scalar implicatures, children's inclusive and conjunctive readings were given unrelated independent accounts: inclusive interpretations were attributed to the absence of pragmatic reasoning (144a), while conjunctive readings were sometimes dismissed as lexical confusion between or and and (144b).

(144) **Accounts for non-adult-like interpretations in the Gricean approach:**
   a. **Inclusive interpretation:**
      Absence of pragmatic reasoning.
   b. **Conjunctive interpretation:**
      Lexical confusion between disjunction and conjunction.

In contrast, under the grammatical approach to scalar implicatures, inclusive interpretations arise because children have not inserted the *Exh* operator into the structure (145a).[25] Conjunctive readings can be accounted for by assuming that the exhaustification procedure is acquired but is applied with respect to a set of alternatives that lacks the conjunctive alternative (145b; Tieu et al., 2017; Singh et al., 2016).

(145) **Accounts for non-adult-like interpretations in the grammatical approach:**
   a. **Inclusive interpretation:**
      Exh is not acquired or vacuous strengthening.
   b. **Conjunctive interpretation:**
      Exh is acquired but incomplete set of alternatives.

For this book, we take position against the traditional Gricean approach and side with the grammatical approach. This choice is motivated by the two reasons below. First, the predictions of the traditional Gricean approach do not match the available empirical data: it is now well established that (i) children are capable of producing pragmatically complex meanings, though not always like adults (see Barner & Bachrach, 2010; Barner et al., 2011); and (ii) children do not confuse logical connectives (Su, 2014; Su & Crain, 2010). Second, the grammatical approach offers the formal tools necessary to provide a unified analysis of children's non-adult-like readings of disjunction across a wide range of environments, including

[25] See, however, Chapter 3 and 4 where we show that there are in fact more than one way of being inclusive, including an adult-like one.

matrix clauses, under negation (Chapters 3 and 4), and under modals (Chapter 5). In particular, we will develop the idea that children prefer to resolve ignorance as early as possible in the syntactic structure, a move that would have been impossible if pragmatic strengthening were not modelled at the compositional level.

Notice that we specifically adopt Fox's (2007) original formulation of the exhaustification procedure, rather than the more recent version proposed by Bar-Lev and Fox (2020), which differs in how the procedure is modelled. This choice is motivated by the fact that the revised version offers no further explanatory advantages for our developmental data than the original version. Moreover, Fox's (2007) approach has reached a certain level of theoretical maturity: it is well-established, its empirical scope is well-documented, and it is less controversial than the revised version.

Finally, and most importantly, the reader should keep in mind that the empirical generalisations we develop in this book regarding children's interpretations of disjunction will hold independently of the theoretical framework in which we embed our analysis. The theoretical contribution may lose relevance over time, but the acquisition facts remain.

Chapter 3

The acquisition of simple versus negated disjunction: Comparing interpretations across contexts

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1 Introduction

Children have been reported to interpret statements with simple disjunction (1) and sentences with negated disjunction (2) differently from adults.

(1) Liz a colorié la fleur ou l'arbre.
Liz AUX.PRS.3SG color.PART.PST the flower or the.tree
"Liz colored the flower or the tree."
a. **Exclusive interpretation:**
Liz either colored the flower or she colored the tree.
b. **Inclusive interpretation:**
Liz colored the flower or the tree, possibly both.
c. **Conjunctive interpretation**
Liz colored both the flower and the tree.

(2) Liz n'a pas colorié la fleur ou l'arbre.
Liz NEG.AUX.PRS.3SG NEG color.PART.PST the flower or the.tree
"Liz did not color the flower or the tree."
a. **Exclusive interpretation:**
Liz either did not color the flower or she did not color the tree.
b. **Not both interpretation:**
Liz did not color the flower or she did not color the tree, possibly neither.
c. **Neither...nor interpretation:**
Liz colored neither the flower nor the tree.

These findings come from two separate strands of research and different explanations have been offered for the two sets of findings. In the case of simple disjunction, whereas adults typically access an *exclusive* interpretation (1a), acquisition studies have shown that children of age 4 to 5 rather adopt an *inclusive* (1b; Boster and Crain 1993; Chierchia et al. 2001b, 2001a; Singh et al. 2016; Tieu et al. 2017; Cochard et al. 2023; Sauerland and Yatsushiro 2018; Pagliarini et al. 2018a; Goro et al. 2006; Huang and Crain 2020; Su 2014; Su and Crain 2010; Bleotu et al. 2023) or a *conjunctive* interpretation (1c; Braine and Rumain 1981; Paris 1973; Tieu et al. 2017; Singh et al. 2016; Lobina et al. 2023a; Cochard et al. 2023; Bleotu et al. 2023). These non-adult-like interpretations have been attributed to children's difficulties with pragmatic reasoning itself or with some of its components.

In the case of negated disjunction, the adult interpretation varies cross-linguistically, ranging from *exclusive* (2a), to *not both* (2b) or *neither...nor* readings (2c). In contrast, acquisition studies have shown that children overwhelmingly favour the *neither...nor* interpretation (2c; Crain et al. 2002; Goro and Akiba 2004; Goro 2007; Geçkin et al. 2018; Verbuk 2006; Cochard et al. 2023; Lee 2010; Jing 2008). This robust non-adult-like pattern has been argued to arise from a developmental principle, the Semantic Subset Principle, which guides children toward a default interpretation (Crain et al., 1994; Crain & Thornton, 1998; Crain, 2008, 2012).

To date, no prior study has compared disjunction across simple and negated contexts. As a result, no uniform analysis has been offered for children's non-adult-like interpretations of disjunction across these two contexts. The current study addresses this gap using a comprehensive design that tests the interpretation of disjunction in both simple and negated environments. Moreover, it also controls several confounding factors in prior experimental setups. Our findings reveal that children show consistent interpretive patterns across both contexts, suggesting that the acquisition of simple and negated disjunctive statements proceeds

in tandem. To account for these patterns, we offer a novel, uniform analysis that models children's grammar across both contexts. Our account builds on Singh et al.'s (2016) core assumption that children have the adult ability to compute scalar implicatures (i.e. strengthen the meaning of a sentence to a stronger one), but are limited in their access to the complete set of alternatives. This restricted access results in non-adult-like interpretations in simple and negated contexts alike.

The chapter is structured as follows: Section 2 provides the semantic and acquisition background on the interpretation of simple and negated disjunction. Section 3 outlines the rationale for the study and Section 4 lays out the predictions. Section 5 presents the methods and Section 6 the results. Section 7 offers a general discussion and Section 8 concludes.

2 Acquiring disjunction in simple and negated contexts

This section provides an overview of previous research on how children interpret disjunction in both simple and negated contexts, along with the theoretical accounts proposed to explain their interpretations. Section 2.1 focuses on simple disjunction, while Section 2.2 addresses negated disjunction.

2.1 Simple disjunction

The disjunctive statement in (3) is typically interpreted exclusively by adults, that is, exactly one of the two disjuncts is taken to be true (3c). This interpretation is derived as an inference, which has been traditionally argued to arise as the consequence of pragmatic reasoning, namely, a scalar implicature. Disjunction and conjunction are ordered on a scale on increasing informativity (Horn, 1972, 1989): conjunction is considered to be more informative because the set of scenarios verifying it (i.e., both conjuncts are true) is a subset of the scenarios verifying disjunction (i.e., at least one disjunct is true). Thus, conjunction is also referred to as the scalar alternative to disjunction (3b). Here, the exclusivity inference in (3c) arises by asserting the literal meaning in (3a) and negating the scalar alternative in (3b).

(3) Liz colored the flower or the tree.

a. **Literal meaning:**
Liz colored the flower or the tree, possibly both. $(P \vee Q)$

b. **Scalar alternative:**
Liz colored the flower and the tree. $(P \wedge Q)$

c. **Exclusivity inference:**
$\rightsquigarrow$ Liz colored the flower or the tree, but not both. $(P \vee Q) \wedge \neg(P \wedge Q)$

Scalar implicatures result from the application of conversational principles. Assuming the speaker and the hearer adhere to general principles of cooperation in conversation and seek to be as informative as possible (Grice, 1975, 1989), upon hearing a disjunctive statement such as (3), the hearer infers that, if the speaker did not utter the conjunctive alternative in (3b), then this alternative must be false. This reasoning results in the strengthening of inclusive disjunction to an *exclusive* interpretation.

In more recent years, the strengthening process of the meaning of a sentence has been formally captured in terms of an Exhaustification operator (Fox, 2007; Chierchia et al., 2011; Bar-Lev & Fox, 2020; Chemla, 2009b). This operator takes for arguments the literal meaning of a sentence, henceforth the prejacent, and the set of alternatives of this sentence to return a strengthened meaning from which as many alternatives as possible have been negated while

preserving the consistency of the reasoning (i.e, without generating any contradiction). Further details are provided in section 2.1.2.

The following subsections present prior findings on the acquisition of simple disjunctive statements and the related accounts. First, section 2.1.1 presents the two non-adult-like interpretations attested in the literature: inclusive (i.e., at least one disjunct is true) and conjunctive readings (i.e., both disjuncts are true). Second, section 2.1.2 introduces the grammatical approach to scalar implicatures in more detail and section 2.1.3 presents Singh et al.'s (2016) account of conjunctive readings of simple disjunction.

2.1.1 Non-target interpretations of disjunction

Acquisition studies have reported that children between four and five years old perform non-adult-like with disjunctive statements. A subset of children was reported to interpret disjunctive statements literally, that is, not deriving the exclusivity inference and showing an inclusive interpretation. This has been established for English (Boster & Crain, 1993; Chierchia et al., 2001b, 2001a; Singh et al., 2016; among others), French (Tieu et al., 2017; Cochard et al., 2023), German (Sauerland & Yatsushiro, 2018), Italian (Pagliarini et al., 2018a), Japanese (Tieu et al., 2017; Goro et al., 2006), Mandarin Chinese (Huang & Crain, 2020; Su, 2014; Su & Crain, 2010), and Romanian (Bleotu et al., 2023)[1], among other languages.

Another subset of children was reported to interpret disjunctive statements conjunctively, assigning the truth-conditions of conjunction to disjunction. This has been found for English (Braine & Rumain, 1981; Paris, 1973; Singh et al., 2016), French (Tieu et al., 2017), Italian (Lobina et al., 2023a), and Japanese (Tieu et al., 2017), among other languages. Table 1 summarises the truth conditions for the two non-adult-like inclusive and conjunctive interpretations, alongside the target exclusive interpretation.

Scenario	**Interpretation of** $(P \vee Q)$		
	Exclusive	Inclusive	Conjunctive
Liz colored both the flower and the tree.	×	✓	✓
Liz colored the flower but not the tree.	✓	✓	×
Liz colored the tree but not the flower.	✓	✓	×
Liz colored neither the flower nor the tree.	×	×	×

Table 1: Truth conditions for three patterns of interpretation of simple disjunction.

On the *inclusive* interpretation, children accept the utterance of a disjunctive statement in situations in which one disjunct is true as well as in situations in which both disjuncts are true, which has been taken to show they do not calculate the exclusivity inference. For instance, in a scenario where Liz colored both the flower and the tree, adults typically reject the use of a disjunctive statement, while (a subset of) children tend to accept it. These findings are parallel with children's performance in other environments that involve scalar terms, such as the quantifier *some*, in which children were reported to not compute scalar

[1] Importantly, not all of these studies tested disjunction in the same environments. For instance, while Tieu et al. 2017 tested disjunction in plain matrix sentences, Su (2014) tested disjunction in the antecedent of a conditional statement. Moreover, comparing the results across studies must be done with caution as they did not involve similar critical and control conditions. For example, whereas Chierchia et al. (2001b) did not include a critical condition where only one disjunct is true, but added controls that included the conjunctive alternative *and*, Tieu et al. (2017) included such a critical condition but did not include controls that included the conjunctive alternative *and*.

implicatures.[2] Children's struggles with scalar implicatures have received various explanations in the literature. In particular, it has been argued that children show pragmatic tolerance in handling pragmatic infelicity (Katsos & Bishop, 2011; Skordos & Papafragou, 2016; Jasbi et al., 2019; Bleotu, 2021), or, alternatively, suffer from processing limitations (Chierchia et al., 2001a; Pouscoulous et al., 2007; Reinhart, 2004) or do not understand the communicative goals of the experimental setups (Papafragou & Musolino, 2003; Papafragou & and, 2004).

On the *conjunctive* interpretation, children accept the utterance of a disjunctive statement only in a situation in which both disjuncts are true, as if disjunction was interpreted as a conjunction. For instance, these children, who we will refer to as *conjunctive* interpreters, accept the use of a disjunctive statement in a scenario in which Liz colored both the flower and the tree. Conversely, *conjunctive* interpreters reject the use of a disjunctive statement in a scenario in which Liz only colored one of the two drawings, either the flower or the tree. The non-target *conjunctive* interpretation of disjunction has been argued to arise as the consequence of a complex pragmatic reasoning (Singh et al., 2016), framed within the grammatical approach to scalar implicatures (Alonso-Ovalle, 2006; Fox, 2007; Chierchia et al., 2011; Bar-Lev & Fox, 2020; Klinedinst, 2007; Chemla, 2009b; Van Rooij, 2010; Franke, 2011).

Contrary to the explanations proposed for *inclusive* interpreters, previous studies have shown that children know how to derive scalar implicatures (Barner & Bachrach, 2010; Barner et al., 2011), and so they are not oblivious to pragmatic reasoning and are capable of pragmatic sophistication, although not necessarily in the same way as adults. Specifically, Singh et al. (2016) argue that, while children have the standard inclusive semantics of disjunction as well as the ability to apply the procedure responsible for generating scalar implicatures, they differ from adults in the alternatives they consider during the procedure. In particular, Singh and colleagues argue that children have difficulties in accessing the lexicon when alternatives are being generated. This results in the absence of any alternative that is generated via lexical replacement, such as the scalar alternative *and* ($P \wedge Q$). The next section provides a detailed presentation of the exhaustification procedure, the pragmatic enrichment mechanism employed in the grammatical approach. Singh and colleagues' account for the *conjunctive* reading is explained in Section 2.1.3.

2.1.2 Modelling the scalar implicature reasoning: The *Exh*austification procedure

The grammatical approach to scalar implicatures provides a formal account of how scalar implicatures arise in natural language (Alonso-Ovalle, 2006; Fox, 2007; Chierchia et al., 2011; Bar-Lev & Fox, 2020; Klinedinst, 2007; Chemla, 2009b; Van Rooij, 2010; Franke, 2011). Central to this framework is the presence of an exhaustification operator, *Exh*, inserted at the syntactic level, which enriches the meaning of a sentence by filtering out specific alternatives. This strengthening process, referred to as exhaustification, can be represented as in (4), where a sentence S is exhaustified with respect to its set of alternatives, yielding an enriched form S^+.

[2] Adults typically interpret the quantifier *some* in sentence (i) as *some but not all* (ia). This interpretation results from the assertion of the literal meaning in (ib) and the negation of the scalar alternative *all* in (ic).

(i) Some giraffes have long necks. (Noveck, 2001)
   a. ⇝ Some giraffes, but not all, have long necks.
   b. Some giraffes, possibly all, have long necks.
   c. All giraffes have long necks.

However, when presented with a sentence such as (i), children of age four to five tend to only show the literal interpretation of *some*, not deriving the scalar implicature (Barner et al., 2011; Guasti et al., 2005; Foppolo et al., 2012; Pouscoulous et al., 2007; Skordos & Papafragou, 2016; Veenstra et al., 2017; Katsos & Bishop, 2011; Jasbi et al., 2019; Bleotu, 2021; among others).

The superscript plus denotes that the sentence underwent one round of exhaustification.

(4) $Exh(ALT(S))(S) \Leftrightarrow S^{+}$

Exh is defined in (5) below, given a prejacent p (i.e., the literal meaning of S) and a set of alternatives $ALT(S)$ (i.e., the set of alternatives of S), *Exh* asserts the prejacent while simultaneously negating all innocently excludable alternatives, that is, alternatives that can be jointly negated without contradicting the prejacent.

(5) **Exhaustivity operator:** (Fox, 2007; p. 25)
$[\![Exh]\!](ALT)(p)(w) \Leftrightarrow (p)(w) \wedge \forall q \in \text{IE}(p, ALT)[\neg q(w)]$

Determining which alternatives are innocently excludable requires the innocent exclusion function in (6). This function selects the intersection of all maximal subsets[3] whose members can be consistently negated together with the prejacent.

(6) **Innocent Exclusion function:** (Fox, 2007; p. 25)
$\text{IE}(p, ALT) = \cap(ALT' \subseteq ALT : ALT'$ is a maximal subset of ALT,
such that $\{\neg q : q \in ALT'(p)\} \cup \{p\}$ is consistent)

Consider a simple disjunctive statement $(P \vee Q)$; its set of alternatives, given in (7), is generated by applying the algorithm in (8) (Katzir, 2007; Fox & Katzir, 2011). This set includes the prejacent (8a), the individual disjuncts obtained by isolating sub-constituents (8b), and the conjunctive scalar alternative obtained by replacing disjunction with conjunction (8c).

(7) **Set of alternatives for** $(P \vee Q)$**:**
$ALT(P \vee Q) = \{\underbrace{(P \vee Q)}_{\text{Prejacent}}, \underbrace{P, Q}_{\substack{\text{Individual}\\\text{disjuncts}}}, \underbrace{(P \wedge Q)}_{\substack{\text{Conjunctive}\\\text{alternative}}}\}$

(8) **Algorithm to generate the set of alternatives of** $(P \vee Q)$: (Katzir, 2007)
a. Take the prejacent: $(P \vee Q)$ — Prejacent
b. Structural replacement: P and Q — Individual disjuncts
c. Lexical replacement: $(P \wedge Q)$ — Conjunctive alternative

The next step is to identify each subset that includes the largest possible number of alternatives whose members can be jointly negated without contradicting the prejacent (i.e., maximal subsets). In the case of simple disjunction, there are only two such sets, given in (9).[4]

(9) **Maximal subsets of** $(P \vee Q)$**:**
a. $\{P, (P \wedge Q)\}$
b. $\{Q, (P \wedge Q)\}$

The set of innocently excludable alternatives of simple disjunctive statements, henceforth ALT^{IE}, is defined as the intersection of these maximal subsets. The only alternative that is common to both subsets is the conjunctive scalar alternative $(P \wedge Q)$, as shown in (10).

[3] A subset $ALT' \subseteq ALT(S)$ is maximal iff the prejacent of S can be consistently asserted together with the negations of all members in ALT', and no strict superset of ALT' has this property.

[4] $\{P, P \wedge Q\}$ is a maximal subset since $(P \vee Q) \wedge \neg P \wedge \neg(P \wedge Q) \Leftrightarrow Q$ is not a contradiction. In a similar manner $\{Q, P \wedge Q\}$ is a maximal subset since $(P \vee Q) \wedge \neg Q \wedge \neg(P \wedge Q) \Leftrightarrow P$ is not a contradiction. No larger subset can be negated with the prejacent without generating a contradiction.

(10) **Set of Innocently Excludable alternatives of** $(P \vee Q)$**:**
$ALT^{\text{IE}}(P \vee Q) = \{P, (P \wedge Q)\} \cap \{Q, (P \wedge Q)\}$
$= \{(P \wedge Q)\}$

As illustrated with the derivation in (11), exhaustifying a simple disjunctive statement results in the exclusion of the only alternative contained in the set of innocently excludable alternatives, namely, the conjunctive scalar alternative. This exclusion gives rise to the exclusivity inference typically associated with simple disjunction.

(11) $Exh(ALT(P \vee Q))(P \vee Q) \Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\text{IE}}(P \vee Q))}_{\text{Negating IE Alternatives}}$
$\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(P \wedge Q)}_{\text{Exclusivity}}$

The exhaustification procedure does not apply automatically. Fox (2007) defines the licensing condition in (12) which triggers this procedure. Whenever a sentence S generates ignorance inferences, that is, the speaker is unsure about the truth of at least one of the alternatives, the *Exh* operator will be appended to S to resolve as much ignorance as possible.

(12) ***Exh* parsing strategy:** (Fox, 2007)
If a sentence S has an undesirable Ignorance Inference, parse it as $Exh(ALT(S))(S)$.

For instance, a disjunctive statement like "Liz colored the flower or the tree" naturally gives rise to ignorance inferences such as those listed in (13). After applying the exhaustification procedure, some of this uncertainty is resolved: the enriched sentence asserts that Liz did not color both the flower and the tree, thereby eliminating (13c), but it leaves open the possibility that she did either one individually (13a and 13b).

(13) **Ignorance inferences for "*Liz colored the flower or the tree.*":**
a. $\rightsquigarrow$ The speaker ignores whether Liz colored the flower.
b. $\rightsquigarrow$ The speaker ignores whether Liz colored the tree.
c. $\rightsquigarrow$ The speaker ignores whether Liz colored both the flower and the tree.

It is worth noting that since the strengthened sentence still conveys some ignorance, a second round of exhaustification is theoretically possible. However, adult speakers do not proceed beyond a second round when interpreting simple disjunctive statements. As will be shown in the following section, further exhaustification after the first round produces a conjunctive interpretation that conflicts with the exclusivity inference established in the first round, leading to contradiction unless specific assumptions are drawn.

2.1.3 Accounting for non-adult-like conjunctive interpretations

To account for children's conjunctive readings of simple disjunctive statements, Singh et al. (2016) formulated a three-step proposal. First, they assumed that disjunction retains its literal boolean meaning in the children's grammar (i.e. at least one disjunct is true). Second, children know how to strengthen the meaning of a sentence to a stronger one (e.g., through the exhaustification procedure). Third, children do not have access to the same set of alternatives as adults. Specifically, recall that Singh and colleagues argue that children fail to generate alternatives that require a lexical replacement. As a result, the child set of alternatives in (14b), lacking the conjunctive alternative, is a subset of the adult set in (14a).

(14) a. **Adult set of alternatives for** $(P \vee Q)$**:**

$$ALT(P \vee Q) = \{\underbrace{(P \vee Q)}_{\text{Prejacent}}, \underbrace{P, Q}_{\substack{\text{Individual}\\\text{disjuncts}}}, \underbrace{(P \wedge Q)}_{\substack{\text{Conjunctive}\\\text{alternative}}}\}$$

b. **Child set of alternatives for** $(P \vee Q)$**:** (Singh et al., 2016)

$$ALT_{\text{CHILD}}(P \vee Q) = \{\underbrace{(P \vee Q)}_{\text{Prejacent}}, \underbrace{P, Q}_{\substack{\text{Individual}\\\text{disjuncts}}}\}$$

The incomplete set of alternatives in (14b) has a critical consequence for the pragmatic enrichment procedure that follows: the two maximal subsets of the child set of alternatives (15) do not have any intersecting components. Thus, the set of innocently excludable alternatives is empty, (16). Reasoning with an empty set means that the output meaning will not be strengthened in any way (17), that is, there is no change in the output meaning. Note the superscript plus sign in $(P \vee Q)^+$ to indicate that the statement underwent a first round of exhaustification.

(15) **Maximal subsets of** $ALT_{\textbf{CHILD}}(P \vee Q)$**:**

a. $\{P\}$

b. $\{Q\}$

(16) **Set of innocently excludable alternatives of** $ALT_{\text{CHILD}}(P \vee Q)$**:**

$$\begin{aligned} ALT^{\text{IE}}_{\text{CHILD}}(P \vee Q) &= \{P\} \cap \{Q\} \\ &= \varnothing \end{aligned}$$

(17) **First round of exhaustification:**

$$\begin{aligned} Exh(ALT_{\text{CHILD}}(P \vee Q))(P \vee Q) &\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg ALT^{\text{IE}}_{\text{CHILD}}(P \vee Q)}_{\text{Negating IE Alternatives}} \\ &\Leftrightarrow \underbrace{(P \vee Q)^+}_{\text{Prejacent}} \end{aligned}$$

The derivation in (17), however, is not entirely vacuous. The exhaustification procedure also applies to each member of the base set of alternatives[5], generating the set of strengthened alternatives in (18). Moreover, as ignorance about the individual disjuncts has not been resolved, the *Exh* parsing strategy applies again and triggers a second round of exhaustification.

(18) **Child set of alternatives of** $(P \vee Q)^+$**:**

$$\begin{aligned} ALT_{\text{CHILD}}(P \vee Q)^+ &= \{Exh(P \vee Q), Exh(P), Exh(Q)\} \\ &= \{\underbrace{(P \vee Q)}_{\text{Prejacent}}, \underbrace{(P \wedge \neg Q)}_{\text{Only P}}, \underbrace{(Q \wedge \neg P)}_{\text{Only Q}}\} \end{aligned}$$

[5] The set of exhaustified alternatives is obtained by exhaustifying each base alternative with regards to the set of alternatives of disjunction as in (i).

(i) a. $Exh(P \vee Q)(P \vee Q) \Leftrightarrow (P \vee Q) \wedge \neg(P \wedge Q)$

b. $Exh(P \vee Q)(P) \Leftrightarrow (P \wedge \neg Q)$

c. $Exh(P \vee Q)(Q) \Leftrightarrow (Q \wedge \neg P)$

d. $Exh(P \vee Q)(P \wedge Q) \Leftrightarrow (P \wedge Q)$

The set of innocently excludable alternatives for this second round, given in (20), is composed of the two members of the only maximal subset of $(P \vee Q)^+$ in (19), that is the two exhaustified, pragmatically enriched, individual disjuncts.

(19) **Maximal subsets of $ALT_{\text{CHILD}}(P \vee Q)^+$:**
$\{(P \wedge \neg Q), (Q \wedge \neg P)\}$

(20) **Set of innocently excludable alternatives of $ALT_{\text{CHILD}}(P \vee Q)^+$:**
$ALT^{\text{IE}}_{\text{CHILD}}(P \vee Q)^+ = \{(P \wedge \neg Q), (Q \wedge \neg P)\}$

Negating these two exhaustified alternatives yields a *conjunctive* interpretation, as demonstrated by the derivation in (21).

(21) **Second round of exhaustification:**

$$Exh(ALT_{\text{CHILD}}(P \vee Q)^+)(P \vee Q)^+ \Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg ALT^{\text{IE}}_{\text{CHILD}}(P \vee Q)^+}_{\text{Negating IE Alternatives}}$$

$$\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(P \wedge \neg Q)}_{\text{Not only P}} \wedge \underbrace{\neg(Q \wedge \neg P)}_{\text{Not only Q}}$$

$$\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \quad \underbrace{(P \leftrightarrow Q)}_{\text{Both true or both false}}$$

$$\Leftrightarrow \underbrace{(P \wedge Q)}_{\text{Conjunction}}$$

It is important to keep in mind that, had exclusivity been generated in the first round, it would have contradicted the conjunctive inference generated in the second round. As a result, when the set of alternatives under consideration contains the conjunctive alternative, thus allowing for the exclusivity inference to be derived, the second round of exhaustification will crash. This explains why adults typically only maintain the meaning derived in the first round of exhaustification when interpreting simple disjunctive statements. However, when the set of alternatives under consideration does not contain the conjunctive alternative, the second round of exhaustification does not generate any contradiction. Thus, the resulting conjunctive interpretation is maintained.

In the next section, we turn to negated disjunction and the related accounts to explain both the variation in adults' interpretation and the non-target readings.

2.2 Negated disjunction

We now turn to disjunctive statements embedded under negation. Section 2.2.1 outlines the possible interpretations for negated disjunctive statements while Section 2.2.2 presents a well-established account of cross-linguistic variation in adult grammars. In Section 2.2.3, several acquisition studies will be reviewed including an explanation of children's non-adult-like interpretation couched within the Semantic Subset principle account in Section 2.2.3. Finally, Section 2.2.4 offers a grammatical account for a specific interpretation of negated disjunction, namely the *neither...nor* reading. Importantly, this explanation extends Singh et al.'s (2016) analysis to negated environments, showing that the *neither...nor* reading can be obtained under the assumptions that children cannot generate the conjunctive alternative and, moreover, that disjunction scopes out of negation. Notably, this analysis sets the stage for the hypotheses that

will be tested in our study.

2.2.1 Negated disjunction in the adult grammar

Consider the negated disjunctive statement in (22) which has the three possible readings in (23). On the *neither...nor* reading in (23a), a speaker accepts negated disjunctive statements only when both disjuncts are taken to be false. On the *not both* interpretation in (23b), a speaker accepts negated disjunctive statements when at least one disjunct is taken to be false. On the *exclusive* interpretation in (23c), a speaker accepts negated disjunctive statements when exactly one disjunct is false.

(22) Liz did not color the flower or the tree.

(23) a. **Neither...nor interpretation:** $(\neg P \wedge \neg Q)$
Liz colored neither the flower nor the tree.
b. **Not both interpretation:** $(\neg P \vee \neg Q)$
Liz did not color the flower or she did not color the tree, possibly neither.
c. **Exclusive interpretation:** $(\neg P \vee \neg Q) \wedge \neg(\neg P \wedge \neg Q)$
Liz either did not color the flower or she did not color the tree.

Table 2 below summarises the truth conditions associated with the three interpretive patterns of negated disjunction: the *neither...nor*, the *not both*, and the *exclusive* interpretations.

Scenario	**Interpretation of $\neg(P \vee Q)$**		
	Exclusive	Not both	Neither...nor
Liz colored both the flower and the tree.	×	×	×
Liz colored the flower but not the tree.	✓	✓	×
Liz colored the tree but not the flower.	✓	✓	×
Liz colored neither the flower nor the tree.	×	✓	✓

Table 2: Truth conditions for three patterns of interpretation of negated disjunction.

Logically speaking, following De Morgan's laws, given in (24), a negated disjunctive should only receive the *neither...nor* or the *not both* interpretations, depending on the scope relationship between negation and disjunction. If negation takes scope over disjunction (24a; $\neg[P \vee Q]$), the sentence receives a *neither...nor* interpretation $(\neg P \wedge \neg Q)$. Conversely, if disjunction takes scope over negation (24b; $\neg P \vee \neg Q$), the sentence receives a *not both* interpretation (which can also be rewritten as $\neg[P \wedge Q]$, hence the *not both* label).

(24) **De Morgan's laws:**
a. $\neg(P \vee Q) \Leftrightarrow (\neg P \wedge \neg Q)$ *Disjunction scopes below negation*
b. $(\neg P \vee \neg Q) \Leftrightarrow \neg(P \wedge Q)$ *Disjunction scopes above negation*

In the latter case where disjunction scopes above negation, a scalar implicature can be calculated to yield the *exclusive* interpretation. Importantly, the scalar implicature responsible for this interpretation in negated disjunctive statements uses the same mechanism that gives rise to the *exclusive* interpretation in simple disjunctive statements. To illustrate, consider example (25). The scalar alternative with *and* in (25b) is the most informative alternative to (25a). Upon negating this alternative, the *exclusive* interpretation in (25c) is derived.

(25) Liz did not color the flower or the tree.

a. **Not both interpretation:**
Liz did not color the flower or she did not color the tree, possibly neither.

b. **Conjunctive alternative:**
Liz did not color the flower and she did not color the tree.

c. **Exclusivity inference:**
Liz did not color the flower or she did not color the tree, but it is not the case that she colored neither.

Within the grammatical approach to scalar implicatures, the reasoning is similar to the derivation in (11) for simple disjunctive statements. Given the set of alternatives in (26), the two maximal subsets that can be excluded consistently with the prejacent are given in (27).

(26) **Set of alternatives for** $(\neg P \vee \neg Q)$**:**

$$ALT(\neg P \vee \neg Q) = \{\underbrace{(\neg P \vee \neg Q)}_{\text{Prejacent}}, \underbrace{\neg P, \neg Q}_{\substack{\text{Individual}\\\text{disjuncts}}}, \underbrace{(\neg P \wedge \neg Q)}_{\substack{\text{Conjunctive}\\\text{alternative}}}\}$$

(27) **Maximal subsets for** $ALT(\neg P \vee \neg Q)$**:**

a. $\{\neg P, (\neg P \wedge \neg Q)\}$

b. $\{\neg Q, (\neg P \wedge \neg Q)\}$

The resulting set of innocently excludable alternatives, given in (28) is the intersection of these two subsets, which only includes the scalar conjunctive alternative. Applying the exhaustification procedure over this set, as shown in (29), yields the *exclusive* reading.

(28) **Set of innocently excludable alternatives of** $ALT(\neg P \vee \neg Q)$**:**

$$\begin{aligned} ALT(\neg P \vee \neg Q) &= \{\neg P, (\neg P \wedge \neg Q)\} \cap \{\neg Q, (\neg P \wedge \neg Q)\} \\ &= \{(\neg P \wedge \neg Q)\} \end{aligned}$$

(29) $$\begin{aligned} Exh(ALT(\neg P \vee \neg Q))(\neg P \vee \neg Q) &\Leftrightarrow \underbrace{(\neg P \vee \neg Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\text{IE}}(\neg P \vee \neg Q))}_{\text{Negating IE Alternatives}} \\ &\Leftrightarrow \underbrace{(\neg P \vee \neg Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(\neg P \wedge \neg Q)}_{\text{Exclusivity}} \end{aligned}$$

Notice, further, that when disjunction scopes below negation, yielding a *neither...nor* interpretation, no pragmatic enrichment is expected. This is because the licensing condition that triggers the exhaustification procedure is no longer satisfied. Under the *neither...nor* interpretation, there is no ignorance regarding the truth of the individual disjuncts: both are known to be false. As a result, the *Exh* parsing strategy, which depends on the presence of ignorance, does not apply in this configuration.

2.2.2 Cross-linguistic variation

As we have just seen in the previous section, negated disjunctive statements theoretically allow for three possible interpretations. However, they are not uniformly interpreted across languages: in some languages such as Hungarian (Szabolcsi, 2002), Russian (Verbuk, 2006) and Italian (Pagliarini et al., 2018b, 2022), speakers have a preference for the *exclusive* interpretation of negated disjunction. Conversely, in languages such as English (Chierchia et al., 2001a), Dutch

(Pagliarini et al., 2022) and Korean (Lee, 2010), experimental findings show a clear preference for the *neither...nor* reading. To account for this cross-linguistic difference, Szabolcsi (2002) proposed that disjunction is subject to a positive polarity parameter varying across languages. This parameter determines whether disjunction should be interpreted below or above negation. When disjunction is a positive polarity item, it has to scope above negation, thus allowing the *not both* and the *exclusive* readings, but not the *neither...nor* one. Conversely, when disjunction is not a positive polarity item, its scope is not constrained, allowing for all three interpretations to arise.

This cross-linguistic difference has attracted considerable attention in the literature. Table 3 provides a non-exhaustive list of languages, classified by whether the alleged preferred interpretation corresponds to the *exclusive* or the *neither...nor* interpretation.[6]

Preference for *Exclusive* **(OR > NEG + Implicature)**	**Preference for *Neither...nor*** **(NEG > OR)**
Catalan (Pagliarini et al., 2021) **French** (Cochard et al., 2023; Lungu et al., 2021; Pagliarini et al., 2022) **Hungarian** (Szabolcsi, 2002; Surányi & Gulás, 2022) **Italian** (Pagliarini et al., 2018b, 2022) **Japanese** (Goro & Akiba, 2004; Goro, 2007) **Mandarin Chinese** (Jing, 2008) **Russian** (Verbuk, 2006) **Turkish** (Geçkin et al., 2018)	**Bulgarian** (Szabolcsi, 2002) **Dutch** (Pagliarini et al., 2022; van Hout et al., 2024) **English** (Larson, 1985; Chierchia et al., 2004; Lungu et al., 2021) **German** (Geçkin et al., 2018) **Greek** (Szabolcsi, 2002; Tsakali, 2021) **Korean** (Lee, 2010; O'Grady et al., 2011; Lee & Schwartz, 2024) **Romanian** (Lungu et al., 2021; Szabolcsi, 2002) **Spanish** (Lobina et al., 2023b; Becerra Zita et al., 2014) **Warlpiri** (Bowler, 2014)

Table 3: Classification of languages with respect to the alleged preferred interpretation.

Notice that this typology should actually be nuanced. In some of these languages, empirical findings show that, while speakers have a strong preference towards one interpretation, the alleged unavailable interpretation is also available. For instance, in Japanese, Tomioka (2014) showed that an elided constituent taking a negated disjunctive statement for antecedent systematically received a *neither...nor* interpretation. In French, Larralde et al. (2021) reported that their adult control group showed a consistent *neither...nor* interpretation contrary to the traditional assumption that French only allows for the exclusive interpretation (Nicolae, 2017; Spector, 2014). In French, Italian and Romanian, Lungu et al. (2021) showed that adults rated continuations of negated disjunctive enforcing the alleged unavailable reading highly, suggesting that more than one reading is available in these languages.

2.2.3 Acquiring negated disjunction: a default *neither...nor* interpretation

Whereas the adult interpretation of negated disjunction varies depending on the language, many acquisition studies have found that four- to five-year-old children showed a clear preference for the *neither...nor* interpretation, regardless of the language, even in languages where adults

[6] Several of the studies cited in Table 3 are acquisition studies, in which the preference for the *exclusive* or the *neither...nor* interpretation of the language under investigation is established by the adult control group.

prefer the *exclusive* reading. Unsurprisingly, the *neither...nor* interpretation has been found in languages where it corresponds to the adult-like reading, e.g. for Dutch (Pagliarini et al., 2022), English (Chierchia et al., 2001a, 2004), German (Geçkin et al., 2018), for Korean (Lee, 2010), among other languages and studies. But in languages where the adult preference goes for the *exclusive* reading, children initially have the *neither...nor* reading, which is the non-adult-like interpretation in these languages, e.g. for Catalan (Pagliarini et al., 2021), French (Larralde et al., 2021; Pagliarini et al., 2022), Hungarian (Pagliarini et al., 2022), Italian (Pagliarini et al., 2022), Japanese (Goro & Akiba, 2004; Goro, 2007), Russian (Verbuk, 2006), Turkish (Geçkin et al., 2018), among other languages and studies.

The preference for the *neither...nor* reading has been explained as an effect of the Semantic Subset Principle (Crain et al., 1994)[7], a developmental learnability principle that determines children's interpretation when they are confronted with logically ambiguous sentences. According to this principle, given in (30), when two possible readings stand in a subset-superset relation, children are predicted to initially default to the interpretation that is true in the least range of circumstances, i.e. the subset reading.[8]

(30) **Semantic Subset Principle** (Crain et al. 1994; p. 455)
If the interpretative component of UG makes two interpretations, A and B, available for a sentence S, and if interpretation A makes S true in a narrower range of circumstances than interpretation B does, then interpretation A is hypothesized before B in the course of language development.

In the case of negated disjunctive statements, the Semantic Subset Principle predicts that children default to the *neither...nor* interpretation (i.e., the subset reading), as this interpretation is only true in one scenario, when both disjuncts are false. Conversely the *not both* interpretation (i.e., the superset reading) is true in three scenarios, when only the first disjunct, only the second disjunct, or when both disjuncts are false. This explanation has been put forward in the numerous acquisition studies listed above to explain the non-adult-like *neither...nor* reading in languages where disjunction is analysed as a positive polarity item (e.g. French; Pagliarini et al. 2022). In Section 7.4, we discuss whether this Semantic Subset Principle explanation can be maintained in light of the results in our study.

2.2.4 A grammatical account of non-adult-like *neither...nor*

In this section, we offer a grammatical account of children's non-adult-like *neither...nor* reading, extending Singh et al.'s (2016) account for simple disjunction to negated disjunction. Specifically, we argue that children apply a form of strengthening similar to the conjunctive strengthening account proposed by Singh and colleagues who argued that some children strengthened the meaning of simple disjunction to the meaning of conjunction (see Section 2.1.2). Using the same premises (i.e. children have the ability to pragmatically enrich sentences

[7] Updated versions of the SSP have been proposed to account for cross-linguistic variation (Musolino et al., 2000) or for a wider range of phenomena (Moscati & Crain, 2014) such as modals appearing in negative environments. However, for this chapter, we adopt the initial version of the SSP proposed by Crain et al. (1994) for two reasons. First, this version of the SSP suffices to explain the acquisition facts with negated disjunction. Second, it is the less controversial version of this developmental principle. For a more comprehensive criticism of the SSP, see Musolino et al. (2019) who highlight its empirical shortcomings and conceptual issues.

[8] The Semantic Subset Principle from Crain et al. (1994) bears resemblance with the Stronger Meaning Hypothesis developed by Dalrymple et al. (1994). While both deal with meaning selection in sentences allowing more than one interpretation, they apply to different domains (language acquisition vs. syntax-semantics interface) and have distinct theoretical motivations (which interpretation arises first vs. which interpretation is preferred).

but they lack the lexical alternative *and*), we argue that it is plausible that some children strengthen negated disjunctive statements toward a *neither...nor* interpretation, as this will be detailed below.

In a similar manner as the derivation of the *exclusive* interpretation in negated disjunction is strictly parallel to the derivation of the same interpretation in simple disjunction, we propose that the derivation of the non-adult-like *neither...nor* interpretation mirrors the derivation of the non-adult-like *conjunctive* interpretation in simple disjunction (see section 2.1.2; Singh et al. 2016)[9]. Crucially, this approach implies that interpretations of disjunction across simple and negated contexts are related. If children lack the lexical alternative *and*, it will be absent in both contexts alike. This makes predictions for acquisition that will be formulated in detail in Sections 3 and 4.

The derivation of the *neither...nor* interpretation via a grammatical approach follows the same steps as for the conjunctive strengthening of simple disjunction, with the extra assumption that disjunction is interpreted above the scope of negation. The child set of alternatives for the first round of exhaustification of wide scope negated disjunction (OR > NEG) is given in (31). The corresponding maximal subsets are given in (32).

(31) **Child set of alternatives for** $(\neg P \vee \neg Q)$**:**

$$ALT_{\text{CHILD}}(\neg P \vee \neg Q) = \{\underbrace{(\neg P \vee \neg Q)}_{\text{Prejacent}}, \underbrace{\neg P, \neg Q}_{\substack{\text{Individual}\\ \text{disjuncts}}}\}$$

(32) **Maximal subsets of** $ALT_{\textbf{CHILD}}(\neg P \vee \neg Q)$**:**

a. $\{\neg P\}$

b. $\{\neg Q\}$

As there is no intersecting component between the two sets in (32), there is no innocently excludable alternative to negate as shown in (33). Consequently, the exhaustification procedure illustrated in (34) does not yield any change in meaning.

(33) **Set of innocently excludable alternatives of** $ALT_{\textbf{CHILD}}(\neg P \vee \neg Q)$**:**

$$\begin{aligned} ALT^{\text{IE}}_{\text{CHILD}}(\neg P \vee \neg Q) &= \{\neg P\} \cap \{\neg Q\} \\ &= \varnothing \end{aligned}$$

(34) **First round of exhaustification:**

$$\begin{aligned} Exh(ALT_{\text{CHILD}}(\neg P \vee \neg Q))(\neg P \vee \neg Q) &\Leftrightarrow \underbrace{(\neg P \vee \neg Q)}_{\text{Prejacent}} \wedge \underbrace{\neg ALT^{\text{IE}}_{\text{CHILD}}(\neg P \vee \neg Q)}_{\text{Negating IE Alternatives}} \\ &\Leftrightarrow \underbrace{(\neg P \vee \neg Q)^{+}}_{\text{Prejacent}} \end{aligned}$$

However, ignorance about the individual disjuncts has not been resolved. The speaker still ignores whether Liz did not color the flower and whether Liz did not color the tree. As a result, the *Exh* parsing strategy licenses a second round of exhaustification. The set of relevant

[9] Such a proposition is also found in Bowler (2014) who showed that *neither...nor* readings in Warlpiri can theoretically arise if a wide scope negated disjunctive statement is strengthened with respect to a conjunctive-less set of alternatives. Likewise, Shimada and Goro (2021) suggested that the preference for the *neither...nor* reading observed in 4- to 6-year-old Japanese-speaking children could also be explained in terms of pragmatic enrichment relative to an incomplete set of alternatives.

alternatives for this second round, provided in (35), contains the exhaustified alternatives from the base set.

(35) **Child set of alternatives of $(\neg P \vee \neg Q)^+$:**
$ALT_{\text{CHILD}}(\neg P \vee \neg Q)^+ = \{Exh(\neg P \vee \neg Q), Exh(\neg P), Exh(\neg Q)\}$
$= \{\underbrace{(\neg P \vee \neg Q)}_{\text{Prejacent}}, \underbrace{(\neg P \wedge Q)}_{\text{Only Q}}, \underbrace{(\neg Q \wedge P)}_{\text{Only P}}\}$

The only maximal subset of $(\neg P \vee \neg Q)^+$ consists of both the exhaustified individual disjuncts. As there is only one such subset, every alternative within it is innocently excludable (36). Consequently, the second round of exhaustification of wide scope negated disjunction generates a *neither...nor* interpretation. The corresponding derivation is given (37).

(36) **Set of innoncently excludable alternatives of $ALT_{\text{CHILD}}(\neg P \vee \neg Q)^+$:**
$ALT^{\text{IE}}_{\text{CHILD}}(\neg P \vee \neg Q)^+ = \{(P \wedge \neg Q), (Q \wedge \neg P)\}$

(37) **Second round of exhaustification:**
a. $Exh(ALT_{\text{CHILD}}(\neg P \vee \neg Q)^+)(\neg P \vee \neg Q)^+$
b. (37a) $\Leftrightarrow \underbrace{(\neg P \vee \neg Q)}_{\text{Prejacent}} \wedge \underbrace{\neg ALT^{\text{IE}}_{\text{CHILD}}(\neg P \vee \neg Q)^+}_{\text{Negating IE Alternatives}}$
$\Leftrightarrow \underbrace{(\neg P \vee \neg Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(P \wedge \neg Q)}_{\text{Not only P}} \wedge \underbrace{\neg(Q \wedge \neg P)}_{\text{Not only Q}}$
$\Leftrightarrow \underbrace{(\neg P \vee \neg Q)}_{\text{Prejacent}} \wedge \underbrace{(P \leftrightarrow Q)}_{\text{Both true or false}}$
$\Leftrightarrow \underbrace{(\neg P \wedge \neg Q)}_{\text{Neither...nor}}$

This account presents some theoretical and empirical consequences that we put to test in the study presented in the following sections. First, with this uniform approach it is possible to account for both *conjunctive* and *neither...nor* readings in parallel. Second, it offers an alternative explanation to the Semantic Subset Principle (SSP) for *neither...nor* readings without introducing the same learnability problems that the SSP carries. Third, it makes predictions as to which combinations of patterns in simple and negated disjunctions are expected and not expected. These combinations are detailed in Section 4.

3 Present study

Previous studies have investigated children's performance in simple and negated disjunction as independent phenomena. In simple disjunction, children's non-adult-like readings have been accounted for by two different explanations: either children are not producing scalar implicatures and thus only have access to the literal, inclusive meaning of disjunction (Boster & Crain, 1993; Chierchia et al., 2001b, 2001a; Gualmini et al., 2001; Singh et al., 2016; Tieu et al., 2017; Cochard et al., 2023; Sauerland & Yatsushiro, 2018; Pagliarini et al., 2018a; Tieu et al., 2017; Goro et al., 2006; Huang & Crain, 2020; Su, 2014; Su & Crain, 2010; Bleotu et al., 2023), or they know how to perform pragmatic strengthening but fail to generate the lexical conjunctive alternative, resulting in a conjunctive interpretation of disjunction (Singh et al., 2016; Tieu et al., 2017; Bleotu et al., 2023; Cochard et al., 2023). In negated disjunction,

children were reported to show a preference for the *neither...nor* reading which has been attributed to adherence to the Semantic Subset Principle, which enjoins children to only access the scope configuration that makes the negated disjunctive statement true in the least range of situations (Pagliarini et al., 2022; Goro, 2007; Goro & Akiba, 2004; Geçkin et al., 2018; Lee, 2010; Verbuk, 2006; Cochard et al., 2023; Tsakali, 2021; Chierchia et al., 2001a; Jing, 2008; Pagliarini et al., 2021; among others).

We argued in Section 2.2.4 for a connection between simple and negated disjunction in the learner's developing grammar, in particular, the *neither...nor* reading of negated disjunction can arise through a mechanism similar to the one that yields a *conjunctive* reading for simple disjunction. Here, we hypothesize that the acquisition of disjunction in the two contexts proceeds in parallel. To our knowledge, no study has investigated whether, and, if so, how adult-like and non-adult-like interpretation patterns are related across these two contexts. Addressing this gap by examining how disjunction is interpreted in child French across simple and negative contexts, using the same participants and design, our study seeks to answer the following research questions, (38) and (39).

(38) **Research question 1:**
To what extent is children's interpretation of simple and negated disjunction related?

(39) **Research question 2:**
To what extent is there variation in French adults' interpretation of negated disjunction? Do French-speaking children show the same variation as adults?

To address these questions, we designed an experiment that included both simple and negated disjunctive statements, using the same setup and task. Addressing shortcomings from previous studies, we developed a setup that satisfied the ignorance inference associated with disjunction and included a plausible falsifying condition to ensure that disjunction is uttered felicitously. Our design allowed us to test all possible interpretation patterns, both adult-like and non-adult-like, of simple and negated disjunction. Moreover, combining both contexts within the same setup and within participants allows us to assess whether a given learner's developmental profile of disjunction is consistent across contexts.

Our hypothesis is that the developmental status of disjunction is uniform across simple and negated contexts. In particular, we propose that the developmental status of pragmatic enrichment reasoning and the set of available alternatives are consistent in both types of statements, following the consensus that children are capable of pragmatic sophistication (Barner & Bachrach, 2010; Barner et al., 2011; Singh et al., 2016; among others), but not necessarily in the same way as adults. We predict that if children compute scalar implicatures in one context, they also compute them in the other context. In particular, we propose that pragmatically enriched meanings in simple and negated disjunction arise for the same (non-adult-like) reasons.

To test the hypothesis that adult-like and non-adult-like performance patterns appear consistently across simple and negated contexts, we selected a language where disjunction is known to scope above negation: French. In French, the disjunctive word *ou* "or" is allegedly a positive polarity item (Nicolae, 2017; Spector, 2014). However, choosing French also raised an additional challenge: given that previous studies from Larralde et al. (2021) and Lungu et al. (2021) have shown that French-speaking adults could access the *neither...nor* reading, making it also a legitimate target for children, how can we distinguish a *neither...nor* reading that arises from a genuine adult-like preference for interpreting disjunction below the scope of

negation, from a *neither...nor* reading that arises for non-adult-like reasons (e.g. because of the Semantic Subset Subset Principle or conjunctive strengthening)?

To tease apart the target option from the non-target one, we propose to use performance on simple disjunction as a diagnostic of adult-likeness. If a child interprets disjunction in a target-like manner in a simple context by giving it an *exclusive* interpretation, we assume that she does so in negated contexts as well. Thus, the same child's interpretation in negated disjunction should be treated as adult-like, be it an *exclusive* reading or a *neither...nor* reading. Conversely, if a child gives an *inclusive* or a *conjunctive* reading in the simple context, her interpretation in the negated context should likewise be treated as non-adult-like.

Our study makes a contribution to the acquisition literature on disjunction in simple and negated disjunction, as it determines in depth to what extent learners' interpretations are related across both contexts. In addition, it contributes to the semantic literature of negated disjunction by identifying which interpretation is accessible to French speakers, in particular whether each reading can be paired with one group of speakers.

4 Predictions

Assuming that the developmental status of pragmatic enrichment reasoning and the set of alternatives is uniform across simple and negated contexts, we predict three main patterns of interpretation.

First, children who do not produce pragmatically enriched meanings are predicted to only access the literal meaning of disjunction. In simple contexts, this yields an *inclusive* interpretation ($P \vee Q$). In negated contexts, the resulting interpretation depends on the scope configuration between disjunction and negation. If disjunction takes scope above negation (OR > NEG), these learners should derive a not both reading ($\neg P \vee \neg Q$). In contrast, if negation takes scope over disjunction (NEG > OR), they are expected to arrive at a neither. . . nor reading ($\neg P \wedge \neg Q$) as per De Morgan's laws. Note, importantly, that we do not mean that these children have not acquired the ability to produce enriched meaning, but rather that it is simply not visible in *inclusive* children. This could stem from a genuine inability to do perform pragmatic reasoning, but many studies have also advanced reasons to why children would not exhibit scalar implicatures despite having the ability to do it, including pragmatic tolerance and processing costs (see Section 2.1.1 and the references therein; see also Section 7.3.1).

Second, children who can produce pragmatically enriched meanings but lack the conjunctive alternative are expected to strengthen disjunction differently than adults. In simple contexts, the resulting reasoning yields a *conjunctive* interpretation ($P \wedge Q$), as argued by Singh et al. (2016) and illustrated in Section 2.1.3. In negated contexts, a *neither...nor* interpretation is predicted. However, the latter interpretation can either arise through the same strengthening mechanism as in simple contexts, if disjunction scopes above negation as we proposed in Section 2.2.4, or via De Morgan's laws if disjunction scoped below negation.

Third, children who can produce pragmatically enriched meanings and moreover have access to the complete set of alternatives, including the conjunctive one, are expected to display adult-like interpretations. In simple disjunction, this yields an *exclusive* interpretation ($[P \vee Q] \wedge \neg[P \wedge Q]$). In negated contexts, if disjunction scopes above negation, the predicted interpretation is likewise *exclusive* ($[\neg P \vee \neg Q] \wedge \neg[\neg P \wedge \neg Q]$). In contrast, if negation takes scope over disjunction, the resulting interpretation is expected to be a *neither...nor* reading ($\neg P \wedge \neg Q$).

These three patterns are summarised in Table 4, which maps the nature of pragmatic enrichment (present or absent, via exhaustification) and the set of alternatives (complete or

incomplete) to the corresponding interpretations in both simple and negated contexts.

Status	***Exh***	**Set of alternatives**	**Simple disjunction**	**Negated disjunction**	
				OR > NEG	**NEG > OR**
Target	✓	Complete set $\{P, Q, (P \wedge Q)\}$	Exclusive $(P \vee Q) \wedge \neg(P \wedge Q)$	Exclusive $(\neg P \vee \neg Q) \wedge \neg(\neg P \wedge \neg Q)$	
Non-target	✓	Incomplete set $\{P, Q\}$	Conjunctive $(P \wedge Q)$	Neither...nor $(\neg P \wedge \neg Q)$	Neither...nor $(\neg P \wedge \neg Q)$
Non-target	×		Inclusive $(P \vee Q)$	Not both $(\neg P \vee \neg Q)$	

Table 4: Predicted patterns for simple and negated disjunction, depending on the nature of the set of alternatives and the availability of pragmatic enrichment (through exhaustification).

Moreover, the assumption that the availability of pragmatic enrichment and the developmental status of the set of alternatives is uniform across simple and negated contexts also predicts that certain patterns of interpretation should not occur. Some combinations would be inconsistent, because they make contradictory assumptions about the set of alternatives. For instance, a *conjunctive* interpretation in simple disjunction, which is based on the absence of the conjunctive alternative, paired with an *exclusive* interpretation in negated disjunction, which requires its presence, would indicate such an inconsistent grammar.[10] Table 5 summarises the expected and non-expected interpretations.

		Negated Disjunction		
		Exclusive	Not both	Neither...nor
Simple Disjunction	Exclusive	Target		Possibly target
	Inclusive		Non-target	Non-target
	Conjunctive			Non-target

Table 5: Expected combined patterns of interpretations. Grey cells represent inconsistent patterns.

5 Method

This section introduces a novel experimental design inspired by Goro and Akiba's (2004) methodology, which aimed to investigate the interpretation of disjunction in both simple and negated contexts within the same setup. To our knowledge, this is the first study to compare simple and negated disjunction under identical procedures, conditions, and participant groups. Sections 5.1 provides information on participants, Section 5.2 explains the procedure, and

[10] Notice, however, that it is well known that adults can cancel scalar implicatures. This may happen in one or both contexts, resulting in apparent inconsistent grammars (e.g. *exclusive* in simple disjunction but *not both* in negated disjunction, and vice versa *inclusive* in simple disjunction but *exclusive* in negated disjunction). As we will see in the results, these cases are marginal for both adults and children.

Section 5.3 describes the critical conditions and the expected response patterns derived from our hypothesis.

5.1 Participants

A total of 96 native French children (M = 6;2, range = 3;5–8;5) participated in the experiment. Children were recruited at their school. To be included in the study, participants had to be native French speakers with no known cognitive, visual or hearing impairments. In addition, 83 native French-speaking adults took part in the experiment (M = 28, range = 13—67). Adult participants were recruited through Prolific[11] and were compensated £2.25 for a 15-minute advertised experiment, in accordance with the platform's recommended hourly rates. Children received no compensation, as the experiment was conducted during school time at the discretion of their teachers. The duration of the experiment ranged from 15 to 25 minutes per child.

5.2 Task and procedure

A truth-value judgement task in prediction mode Crain and Thornton (1998) was used for this study. Participants were told that different animals would participate in various tasks such as coloring drawings, catching bugs or finding objects. The story was framed within a school setting, where a teacher would reward the animals according to their performance on their respective tasks. For each scenario participants had to judge the teaching assistant's guess about the outcome. The item structure is illustrated in Figures 1 to 3. First, participants were introduced to an animal and its assigned task, (40). In this example, a bear was tasked with coloring two drawings.

(40) C'est l'ours. Regarde, il y a une fleur à colorier. Un arbre aussi.
   a. C'est l'ours.
      this.be.3SG.PRS the.bear
      "It's the bear."
   b. Regarde, il y a une fleur à colorier. Un arbre aussi.
      look.IMP.2SG EXPL LOC AUX.3SG.PRS a flower to colour.INF a tree also
      "There is a flower to color. A tree too."

Then, the animal would hide behind a curtain to carry out the activity, as illustrated in Figure 2. An owl, the teacher's assistant, appeared on the right side of the picture to guess what the animal did behind the curtain. Each guess was preceded by a sound effect that suggested thinking to emphasise that the owl was ignorant about what the other character did behind the curtain. The guess was a disjunctive statement, either in a simple, (41), or in a negated context, (42).

(41) **Simple disjunction:**
   Liz l'ours a colorié la fleur ou l'arbre.
   Liz the.bear AUX.3SG.PRS colour.PART.PST the flower or the.tree
   "Liz the bear colored the flower or the tree."

(42) **Negated disjunction:**
   Liz l'ours n'a pas colorié la fleur ou l'arbre.
   Liz the.bear NEG.AUX.3SG.PRS NEG colour.PART.PST the flower or the.tree
   "Liz the bear did not color the flower or the tree."

[11] https://www.prolific.com

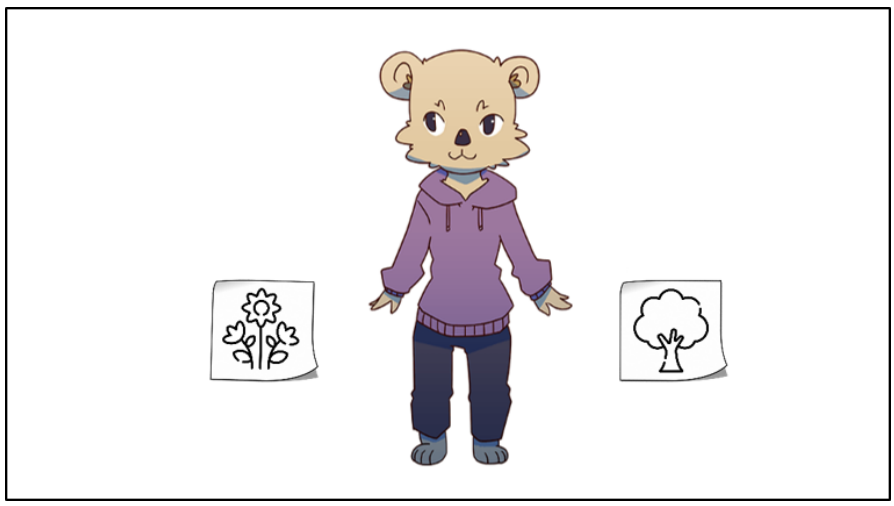


Figure 1: First phase of a trial, displaying the two disjuncts and the character who will perform the task.

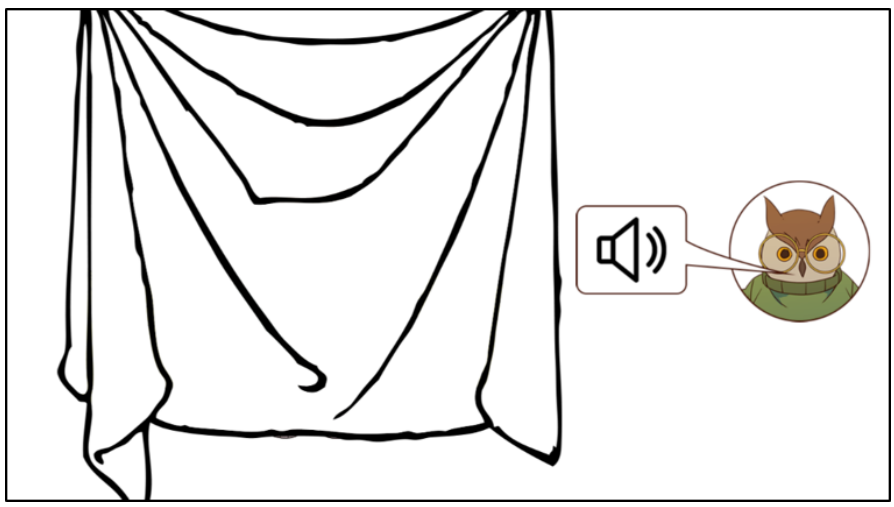


Figure 2: Second phase of a trial, displaying the curtain and the Owl who is uttering the disjunctive guess.

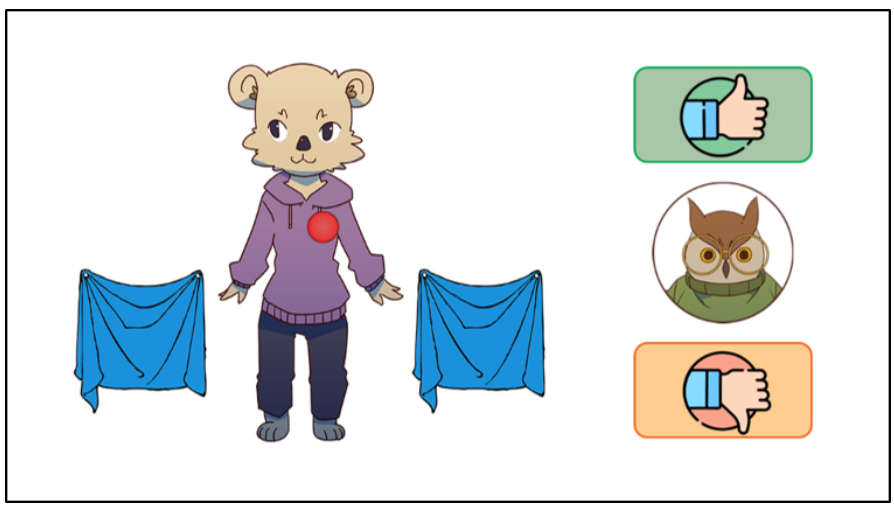


Figure 3: Third phase of a trial, displaying the character's reward and the participant's options to judge the guess as correct (thumb-up) or incorrect (thumb-down button).

After the guess, the curtain rose and revealed the final scene, illustrated in Figure 3. The actual outcome of the task was hidden. The only way to infer what happened was to look at the reward given by the teacher. For example, in Figure 3, the bear received a red dot. Participants had to decide whether or not the owl had made a successful guess by pressing either a thumb-up button (correct) or a thumb-down button (incorrect). When one of the two buttons was pressed, the experiment moved on to the next trial without revealing whether the participant's answer was right or wrong.

One of three possible rewards, shown in Figure 4, was presented, each corresponding to one of three possible outcomes for the task. The red dot sticker (Figure 4a) indicated a situation where the animal did nothing, e.g. the bear did not colour the flowers nor the tree. The solo biscuit (Figure 4b) signified that the character did only one thing, although it remained unclear which one, e.g. the bear coloured one of the two drawings but we do not know which one. Finally, the two biscuits (Figure 4c) represented successful completion of the full task, e.g. the bear coloured the flower and the tree. Participants were familiarized with the reward system during the instruction and training phases of the experiment.

(a) No Disjunct True **(b)** One Disjunct True **(c)** Two Disjuncts True

Figure 4: Pictures of the three possible rewards

This setup addresses two major issues identified in previous studies: ignorance and felicity conditions. Starting with ignorance, Tieu et al. (2017) and Skordos et al. (2020) pointed out that ignorance inferences must be satisfied for disjunction to be felicitously uttered, which was not the case in Singh et al. (2016). Specifically, Singh et al. employed the description mode of the truth-value judgement task in their experiment, presenting the outcome situation with the test sentence. In this setup, participants viewed static story-less pictures depicting either one disjunct true or both disjuncts true. While Singh et al. (2016) argued that this does not undermine their account, basing their conclusion on the observation that the *conjunctive* reading is still generated in universally quantified disjunctive statements where no ignorance inferences are expected, it remains questionable for the simple disjunction segment of their experiment[12]. In contrast, our setup uses the prediction mode of the truth-value judgement task, with the animals hiding behind a curtain so that neither the owl nor the participants witnessed the activity being carried out. By doing so, we ensured that ignorance inferences were satisfied, as the speaker, who utters the disjunctive statement, does not know which disjunct is true.

Second, our setup made the use of disjunction felicitous without having to introduce a contextual third alternative à la Skordos et al. (2020). To utter a felicitous disjunctive statement, the context must offer a plausible falsifying scenario in which neither disjunct is true (Skordos et al., 2020). To create such a context, Skordos et al. introduced a third contextual alternative that the character of the story could potentially engage with, as illustrated in (43). However, this approach suffers from a notable drawback: concluding that the character did not act upon the third object requires the computation of an ad hoc inference (43c).

(43) **Context:** There are drawings of a flower, a tree and a plane to colour. $\{P, Q, R\}$

[12] Furthermore, Singh et al.'s study showed a particularly high exclusion rate. They tested 56 children and had to exclude 25 of them ($\tilde{4}5\%$) who failed controls taking the form of conjunctive statements. Like Tieu et al. (2017) and Skordos et al. (2020), we find this exclusion rate extremely worrisome as it may indicate that the experimental setup was too hard or/and not understood by children.

a. Liz coloured the flower or the tree. $(P \vee Q)$
b. $\rightsquigarrow$ Liz did not colour both the flower and the tree. $\neg(P \wedge Q)$
c. $\rightsquigarrow$ Liz did not colour the plane. $\neg R$

Adding another inference introduces an extra layer of interpretation which complicates the setup and can potentially lead to a misleading Question under Discussion[13], e.g. focusing solely on whether the third object was acted upon (see Huang and Crain 2020, for a study which seems to confirm that it is the case in both adults and children). In such a case, uttering a disjunctive statement might simply convey the speaker's uncertainty about which disjunct is true, potentially allowing for both disjuncts to be true if no exclusivity inference is derived. To avoid these complications, we chose not to have a third alternative in the context. Instead, simple disjunctive statements were falsified by incorporating a plausible scenario where the character does not act upon either of the disjuncts (44). Conversely, negated disjunctive statements were falsified by a situation where the character interacted with both disjuncts (45).

(44) Liz coloured the flower or the tree. $(P \vee Q)$
Falsifying scenario: Liz coloured neither the flower nor the tree. $(\neg P \wedge \neg Q)$

(45) Liz did not colour the flower or the tree. $\neg(P \vee Q)$
Falsifying scenario: Liz coloured both the flower and the tree. $(P \wedge Q)$

The introduction of falsifying scenarios was achieved by manipulating the reward system inherited from Goro and Akiba (2004) and by introducing several key aspects in the story. First, it was explicitly stated in the instruction phase and during training trials that the characters could sometimes fail at their respective tasks. Having the owl occasionally utter negated disjunctive statements further emphasised this side of the story, as negated disjunctive statements always describe a situation where at least one disjunct is false. Yet, as noted by Jing (2008), this could have skewed the Question under Discussion by biasing the answers for negated disjunction towards a *neither...nor* reading. To mitigate this effect, the Question under Discussion was manipulated by emphasising the characters' motivation to succeed. This was done by specifying a school context for the story and by introducing the reward system. The number of biscuits given by the teacher directly depended on task performance. Biscuits were presented as incentives for the characters to complete their task successfully. Notice that we chose to represent the situation where no disjunct was true with a red dot sticker, rather than leaving the character empty-handed. This choice avoided potential confusion about implying that nothing happened at all (e.g. the character did not even try to do her task) or that the teacher was unable to evaluate the animal's performance, which could have led to interpreting the test sentence with the wrong Question under Discussion.

The children were tested individually in a quiet space at their school using a tablet. The adults participated in a web-based version of the experiment, which was coded and hosted using PsyToolkit (Stoet, 2010, 2017).

5.3 Stimuli and design

The design incorporated four critical conditions and two control conditions, structured in a 2 $\times$ 3 factorial design, as shown in Table 6. The conditions varied the type of statement (*simple disjunction* vs. *negated disjunction*) and the number of disjuncts true (*No Disjunct True*, *One*

[13] The Question under Discussion (Groenendijk & Stokhof, 1984; Roberts, 1996; Stalnaker, 1978) refers to the main contextual element under consideration in the discourse. It takes the form of an (implicit) question to which each sentence of the current conversation either answers or updates with new content.

Disjunct True or *Two Disjuncts True*). The design was within-subjects and participants saw six items of each critical condition (24 items total) and three items of each control condition (6 items total), resulting in 30 items overall. Having six items per critical condition allowed us to determine the consistency in a participant's individual answers, which was needed to be able to identify specific patterns for which we used a cluster analysis (see Section 6). It is worth noting that the nature of the control condition differed for each type of disjunctive statement: in simple contexts, the control condition was the *No Disjunct True* condition, whereas in negated contexts it was the *Two Disjuncts True* condition.

Type of disjunctive statement	**Number of Disjuncts True**		
	No Disjunct True 	**One Disjunct True** 	**Two Disjuncts True** 
Simple Disjunction	Control (3 items)	Critical (6 items)	Critical (6 items)
Negated Disjunction	Critical (6 items)	Critical (6 items)	Control (3 items)

Table 6: 2 × 3 factorial design of the experiment crossing the type of disjunction and the number of disjuncts true.

Finally, six filler items served the purpose of balancing the number of yes and no-responses. Like the critical and control items, fillers targeted the character's performance. Moreover, these fillers also checked if participants were paying attention, and, moreover, correctly understood the meaning of the rewards.

(46) Liz l'ours a tout colorié.
Liz the.bear AUX.3SG.PRS everything colour.PART.PST
"Liz the bear coloured everything."

(47) Liz l'ours (n')a rien colorié.
Liz the.bear (NEG.)AUX.3SG.PRS nothing colour.PART.PST
"Liz the bear coloured nothing."

(48) Liz l'ours (n')en a colorié (qu')un seul.
Liz the.bear (NEG.)PRO AUX.3SG.PRS colour.PART.PST THAT.one only
"Liz the bear coloured only one."

All items were compiled into four pseudo-randomized lists, preceded by four training items which were similar to the fillers. Critical items were systematically separated by controls or fillers and never immediately followed another critical item of the same condition. Training items were used to familiarise children with the task. Each training item introduced a different type reward. During training, children were specifically asked to repeat the guess to check that they correctly remembered the test sentence. In case of error, children were corrected and were allowed to repeat the training session once. Children who repeatedly failed on training items were excluded from the experiment.

In total, participants saw 40 items (24 critical items, 6 controls, 6 fillers and 4 training items), all presented together in one session of approximately 20-25 minutes for children and 15 minutes for adults. Except for the training items, participants were not allowed to hear the audio stimuli again. In all test sentences, prosody was neutral, making sure that the statement did not carry any pitch rise, especially not on the disjunctive word *ou* "or". All items and

instructions avoided the use of *et* "and", so as to not provide children with the relevant scalar alternative to disjunction.

5.4 Predicted response patterns

Our hypothesis, outlined in Section 3, posits one obvious adult-like interpretation for simple disjunction and negated disjunction, namely the *exclusive* interpretation. There are two possible non-adult-like interpretations of simple disjunction, the *inclusive* and the *conjunctive* interpretations, and two possible non-adult-like interpretations of negated disjunction, the *not both* and the *neither...nor* interpretations. The *neither...nor* interpretation might be considered as a target reading if it is found in the adults. Tables 7 and 8 below summarise the expected response patterns for each possible interpretation of simple and negated disjunction, respectively.

Interpretation of simple disjunction	**Number of Disjunct True**		
	No Disjunct	**One Disjunct**	**Two Disjuncts**
Exclusive $(P \vee Q) \wedge \neg(P \wedge Q)$			
Inclusive $(P \vee Q)$			
Conjunctive $(P \wedge Q)$			

Table 7: Expected response pattern for each interpretive pattern of simple disjunction.

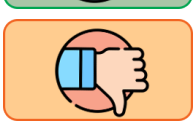
Interpretation of negated disjunction	**Number of Disjunct True**		
	No Disjunct	**One Disjunct**	**Two Disjuncts**
Exclusive $(\neg P \vee \neg Q) \wedge \neg(\neg P \wedge \neg Q)$			
Not both $(\neg P \vee \neg Q)$			
Neither...nor $(\neg P \wedge \neg Q)$			

Table 8: Expected response pattern for each interpretive pattern of negated disjunction.

6 Results

Exclusion of participants from analysis was based on their performance on controls and fillers. Participants were not allowed to make more than one error out of the six controls and no more than one error out of the six fillers. After exclusion, 84 children (M = 6;3, range = 3;6–8;5) and 73 adults (M = 28, range = 18–67) were included in the analysis.[14] The group results and mixed model analyses are reported in Section 6.1, while individual analyses are reported in section 6.2. Age is analyzed in section 6.3.

6.1 Group results and mixed-effects modelling

To examine the contrasts between groups (adults vs. children) as well as within groups (adults only and children only), a series of mixed-effects model analyses was performed. Statistical analyses were done within the R environment (R Core Team, 2023). Mixed models were computed using the *lme4* package (Bates et al., 2015) to fit binomial generalised linear mixed models. To investigate further contrasts in the data, post-hoc pairwise comparisons were computed using the *emmeans* package (Lenth, 2025).

Figure 5[15] reports the performance of adults and children in each condition. At first sight, it appears that children differed from adults on both critical conditions in simple disjunction (*One Disjunct True* and *Two Disjuncts True*). While adults consistently accepted the *One Disjunct True* condition (97.7%), children showed a less firm acceptance rate (73.4%). In the *Two Disjuncts True* condition, a majority of adults rejected the condition (13%), though an individual analysis of the results is required to determine whether the low acceptance rate corresponds to noise or to a few participants who consistently gave an inclusive interpretation (see section 6.2). In contrast, the acceptance rate for the *Two Disjuncts True* condition was higher for children (44.8%).

In negated disjunction, adults and children showed similar performance on the *No Disjunct True* and the *One Disjunct True* conditions. Both groups neither entirely accepted nor rejected the two critical conditions, although children seemed more inclined than adults to accept the *No Disjunct True* condition (61.1% vs. 47.3%) and to reject the *One Disjunct True* condition (68.5% vs. 47%). These results either mean that our participants accepted disjunction about half of the time in these conditions and were likely to be at chance, or that there were two or more populations. This will be revealed in the individual analyses in Section 6.2.

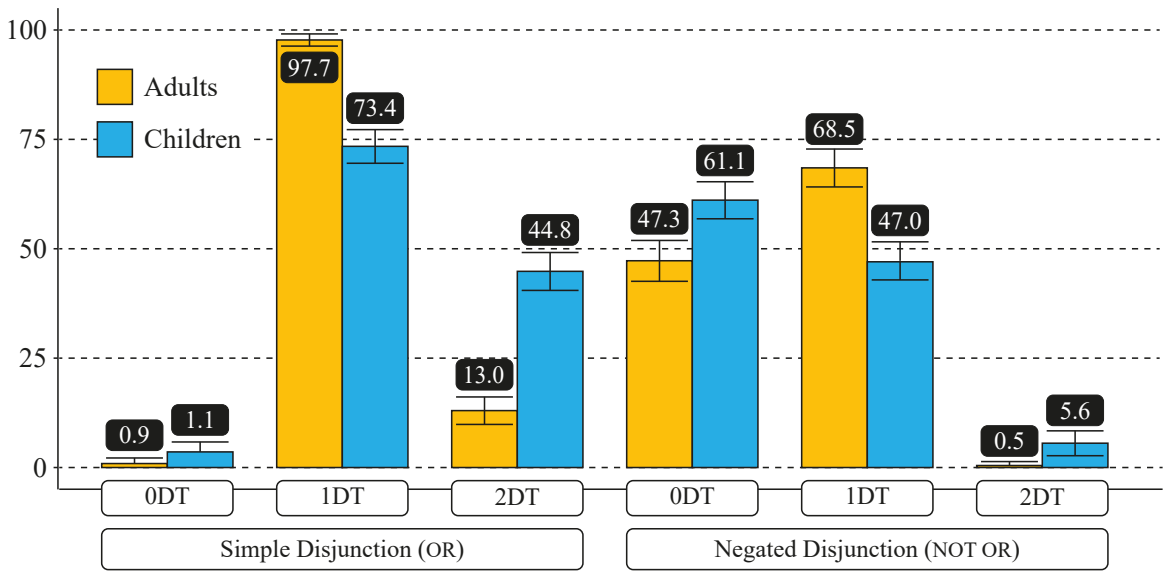


Figure 5: Mean percentage of acceptance for each condition for adults and children. Whiskers represent a 95% confidence interval. DT = Disjunct True.

[14] Five children specifically failed on controls for negated disjunction, one for simple disjunction and another one for both contexts. One child failed on true fillers and the remaining four children failed on a combination of fillers and controls. Out of the twelve excluded children, nine of them failed on controls for negated disjunction. Six adults did not finish the experiment, one failed on true fillers and another failed on controls for negated disjunction. Two other participants declared being below 18 years and were automatically excluded.

[15] See Table A.1 in Appendix A for the complete descriptive statistics.

To compare the overall performance of adults and children, a generalised mixed effects modelling approach was adopted, using the *glmer* function from the *lme4* package. Importantly, the control items (*No Disjunct True* for simple disjunction, and *Two Disjuncts True* for negated disjunction) were removed from the dataset for two key reasons. First, controls were used in addition to filler items to screen participants, ensuring that only those who understood the task were included in the analysis. Second, the study was not designed to compare controls with the critical conditions given a difference in the number of items.

However, dropping the control items introduced a limitation: it prevented the construction of a full-factorial (2×3) model. Specifically, a model that included both the type of disjunctive statement (*Simple context* or *Negated context*) and the number of true disjuncts (*No Disjunct True*, *One Disjunct True* or *Two Disjuncts True*) as factors would be rank-deficient, since not all combinations of these factors were present in the data. The rank deficiency arises because the following combinations would be missing from the matrix table: *Simple context* $\times$ *No Disjunct True* and *Negated context* $\times$ *Two Disjuncts True*. This issue becomes particularly critical when interaction terms are included in the model. As our hypothesis posited that the interpretation of disjunctive statements depends on both the number of disjuncts true and the age group, i.e. adults or children, we aimed specifically to fit interaction models. To address this rank deficiency issue while preserving the hypothesis, we divided the full factorial model into two separate models: one for simple disjunction and another for negated disjunction.[16]

Each model was designed to follow the same hypothesis-driven structure. The binary responses from participants (yes/no) were regressed against the relevant critical conditions (*No Disjunct True* and *One Disjunct True* for negated disjunction, and *One Disjunct True* and *Two Disjuncts True* for simple disjunction), the group (*Adults* vs. *Children*) and the interaction between the number of true disjuncts and age group. Random effects were included for participants and items to account for individual variability in sentence interpretation. Additionally, a random slope of the number of true disjuncts was incorporated into the participant-level random effect to model variation in responses across conditions. The results of the model for simple disjunction are reported in Table 9, and those for negated disjunction are reported in Table 10.

Predictor	**Estimate** (β)	**SE**	z	p
Intercept	6.58	0.78	8.49	$< .001^{***}$
Two Disjuncts True	−12.85	1.28	−10.06	$< .001^{***}$
Children	−4.34	0.75	−5.79	$< .001^{***}$
Two Disjuncts True × Children	9.68	1.45	6.67	$< .001^{***}$

Table 9: Coefficients for simple disjunction. Formula: *answer* ~ *nb_of_disjunct_true* * *group* + *(*1 + *nb_of_disjunct_true* | *participants)* + *(*1 | *items)*

The model for simple disjunction revealed a main effect of the Number of Disjuncts True and the Group. The main effect of the Group suggests that children have not yet reached adult-like proficiency with disjunctive statements, though the area of divergence remains unclear at this stage. Additionally, the model also showed a significant interaction between the Number of Disjuncts True and the Group which further confirms that children performed significantly differently from adults in simple disjunction.

[16] See Table A.2 in Appendix A for a complete non rank deficient model that includes controls.

Predictor	Estimate (β)	SE	z	p
Intercept	−0.08	0.37	−0.21	.832
One Disjunct True	1.47	0.70	2.12	.034*
Children	1.07	0.48	2.22	.027*
One Disjunct True × Children	−2.70	0.93	−2.92	.004**

Table 10: Coefficients for negated disjunction. Formula: *answer* ~ *nb_of_disjunct_true* * *group* + (1 + *nb_of_disjunct_true* | *participants*) + (1 | *items*)

The model for negated disjunction revealed a similar pattern. There was a main effect of the Number of Disjuncts True and group, as well as a significant interaction between the Number of Disjuncts True and the Group.

To further explore the contrasts between adults and children and quantify the differences in their responses, we computed estimated marginal means (EMMs) using post-hoc pairwise comparisons. Table 11 presents the comparisons for simple disjunction, while Table 12 reports the results for negated disjunction.

Contrast	Estimate (β)	SE	z	p
Adults × Children in 1DT	4.34	0.75	5.79	< .001***
Adults × Children in 2DT	−5.34	0.96	−5.56	< .001***
1DT × 2DT in Adults	12.85	1.28	10.06	< .001***
1DT × 2DT in Children	3.17	1.00	3.14	.017**

Table 11: Post-hoc pairwise comparisons: between and within-group contrasts for each condition in simple disjunction. DT = Disjunct True. p values are Tukey-adjusted.

Contrast	Estimate (β)	SE	z	p
Adults × Children in 0DT	−1.07	0.48	−2.22	.027*
Adults × Children in 1DT	1.63	0.50	3.28	.001**
0DT × 1DT in Adults	−1.47	0.70	−2.12	.034**
0DT × 1DT in Children	1.22	0.66	1.88	.061

Table 12: Post-hoc pairwise comparisons: between and within-group contrasts for each condition in negated disjunction. DT = Disjunct True. p values are Tukey-adjusted.

The comparisons between children and adults revealed that both groups indeed differed on every critical condition for each type of disjunctive statement. For simple disjunction, adults were more inclined than children to accept the *One Disjunct True* condition, while they showed the opposite tendency for the *Two Disjuncts True* condition. For negated disjunction, adults were more inclined than children to accept the *One Disjunct True* condition, while they showed, again, the opposite tendency for the *No Disjunct True* condition.

However, there was a critical difference in the effect sizes between simple disjunction and negated disjunction. The difference between adults and children was more pronounced in simple disjunction than it was in negated disjunction. For instance, the effect size between children and adults for the *One Disjunct True* condition in simple disjunction was almost thrice

as big as in negated disjunction. Again, this suggests that children and adults were more alike in negated disjunction than in simple disjunction. The comparisons between conditions also showed a clear difference between simple disjunction and negated disjunction. Both adults and children were more prone to accept the *One Disjunct True* condition than the *Two Disjuncts True* condition in simple disjunction. In negated disjunction, whereas adults were more likely to accept the *One Disjunct True* condition than *No Disjunct True* one, children appeared to be equally likely to accept one or the other condition.

Finally, to capture the variability across and within participants, a closer examination of the random effects for both models is reported in Tables 13 and 14. The random intercept variance for participants indicates a substantial variability in responses across participants, suggesting that individuals tend to give different, but possibly consistent, answers. Furthermore, the random slope variance for the number of disjuncts true shows that these answers were highly sensitive to this factor. This implies that, while participants provided different answers, their answers vary significantly with the Number of Disjuncts True. This hints at different individual response patterns which will be further explored in section 6.2.[17] Finally, the random intercept variance for items indicated that the variability across items marginally contributed to the model, rendering unlikely the possibility that particular items affected the participants' answers.

Random effect	**Variance**	**Std. Deviation**	**Corr.**
Intercept (participants)	8.50	2.92	
Participants × Two Disjuncts True	59.78	7.73	-0.93
Items	0.04	0.20	

Table 13: Random effects for simple disjunction.

Random effect	**Variance**	**Std. Deviation**	**Corr.**
Intercept (participants)	7.52	2.71	
Participants × One Disjunct True	29.34	5.42	-0.98
Items	0.08	0.28	

Table 14: Random effects for negated disjunction.

Overall, the results revealed several key highlights. First, adults and children differed significantly on all critical conditions involving simple disjunction. While children were more likely to accept the *Two Disjuncts True* condition and to reject the *One Disjunct True* condition, adults showed the opposite tendency. A similar divergence was observed in the negated disjunction conditions: children were more likely than adults to accept the *No Disjunct True* condition and to reject the *One Disjunct True* condition. However, unlike in the simple disjunction case, this difference was not statistically significant among children themselves: they were equally likely to accept both conditions. Moreover, the magnitude of these effects differed across the two disjunctive environments. Whereas the discrepancy between adults and children was pronounced in the simple disjunction conditions, their responses appeared more alike in negated disjunction. In the next section, we assess individual variation.

[17] The correlation value indicates a strong tendency for participants who respond "yes" in one condition to respond "no" in the other condition. However, because the data include both adults and children, this correlation should be interpreted with caution. Adults consistently accepted the *One Disjunct True* condition and rejected the *Two Disjuncts True* condition, which likely inflated the negative correlation.

6.2 Individual results

6.2.1 Individual patterns

To assess the consistency of each participant, the responses for each condition were aggregated into a score value ranging from 0 to 6 corresponding to the six items per condition. A score of 0 means that the participant consistently rejected the test sentence in a specific condition; in contrast, a score of 6 indicates that she consistently accepted the test sentence. The distribution of the score values for simple disjunction and negated disjunction are given in Figure 6 and 7.

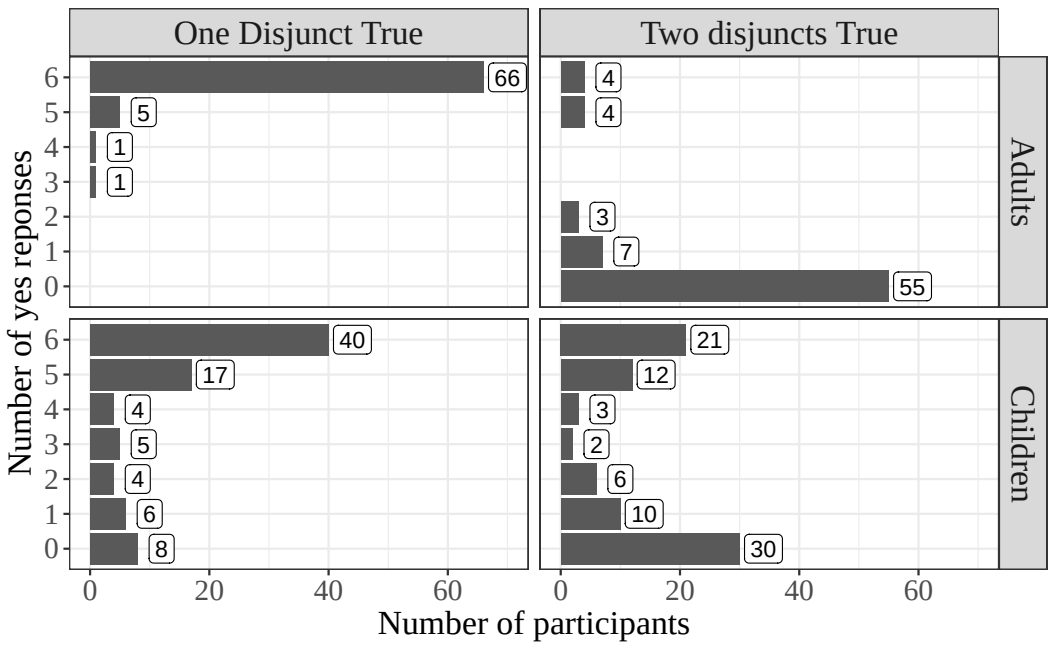


Figure 6: Distribution of the score value across conditions in simple disjunction for adults (n = 73) and children (n = 84).

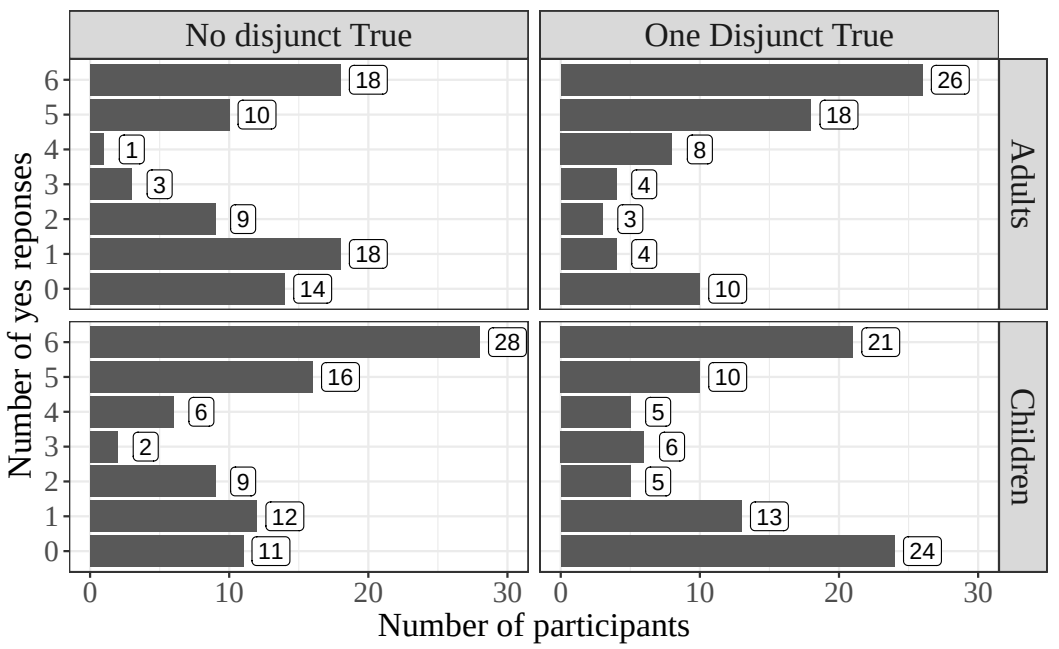


Figure 7: Distribution of the score value across conditions in negated disjunction for adults (n = 73) and children (n = 84).

In simple disjunction, as expected, most adults consistently rejected the *Two Disjuncts True* condition and accepted the *One Disjunct True* condition. Notice that a few adults still consistently accepted the *Two Disjuncts True* condition, and were likely to represent the 13% acceptance rate of this condition in Figure 5. Among children, the majority accepted the *One Disjunct True* condition, while some rejected it. Their responses for the *Two Disjuncts True* condition were more nuanced, some children accepting it while others rejected it.

In negated disjunction, adults' responses were divided into two groups for each condition. The difference between the two groups was more pronounced for the *One Disjunct True* condition where a clear majority accepted it, while a smaller group consistently rejected it. Children, on the other hand, showed the opposite tendency: they were divided into two groups for the *One Disjunct True* condition but showed a stronger preference for accepting the *No Disjunct True* condition.

6.2.2 Simple disjunction cluster analysis

To identify the predicted interpretative patterns in section 4 (see Table 5), a clustering analysis was performed for both simple and negated disjunction in the adults and the children groups.[18] The *cluster* (Maechler et al., 2025) and *factoextra* packages (Kassambara & Mundt, 2020) were used to define and visualise the optimal number of clusters in the dataset. Finally, a k-means algorithm (MacQueen, 1967) was used to identify clusters, iterated 500 times to ensure the robustness of the output. The results for simple and negated disjunction are reported below and in Section 6.2.3, respectively.

The optimal number of clusters for children was determined by visualising the within-cluster sum of squares (WCSS) and using the heuristic elbow method. The "elbow" represents the cut-off point where increasing the number of clusters no longer significantly decreases the WCSS value, which generally appears as an angle in the curve. In Figure 8a, the elbow curve indicates that two is the optimal number of clusters in the adult dataset. This number was double checked by computing a silhouette score to evaluate the clustering quality, illustrated in Figure 8b. The silhouette score measures how distant a data-point is from its own cluster in comparison to the other clusters. The higher the score is, the better the clustering algorithm is. As for the elbow curve, the silhouette score is maximized at two clusters for adults and decreases with any higher number of clusters. For the children dataset, however, the elbow curve and the silhouette score, reported in Figure 9a and 9b respectively, indicate that the optimal number of clusters is three.[19]

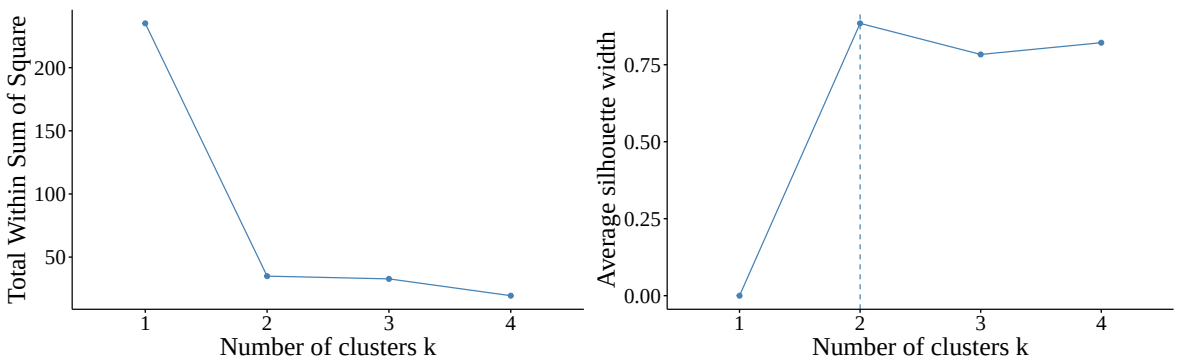
An anomaly detection algorithm was run to identify any data-point whose mean was too distant from a threshold that was computationally defined beforehand.[20] By identifying

[18] In Cochard et al. (2023), we used a numerical criterion to classify children, e.g. 5 or 6 yes-answers out of 6 items was considered as an "accepter" and at most 1 yes-answers out of 6 items to be considered as a "rejecter". Here, we did not use such a criterion, because the cluster analysis allowed more flexibility in the analysis, especially as we had to consider consistent answers from four different conditions to obtain a pattern combining the interpretation of simple disjunction and negated disjunction.

[19] To estimate and choose the optimal number of clusters, we decided, by convention, to visualise the within-cluster sum of squares and the silhouette score. However, these two methods are not the only means to determine the optimal number of clusters and other methods may yield a different number. To ultimately back up our choice, we ran the *NbClust* function from the *NbClust* package (Charrad et al., 2014) that compares up to 30 indices to determine the relevant number of clusters in a dataset.

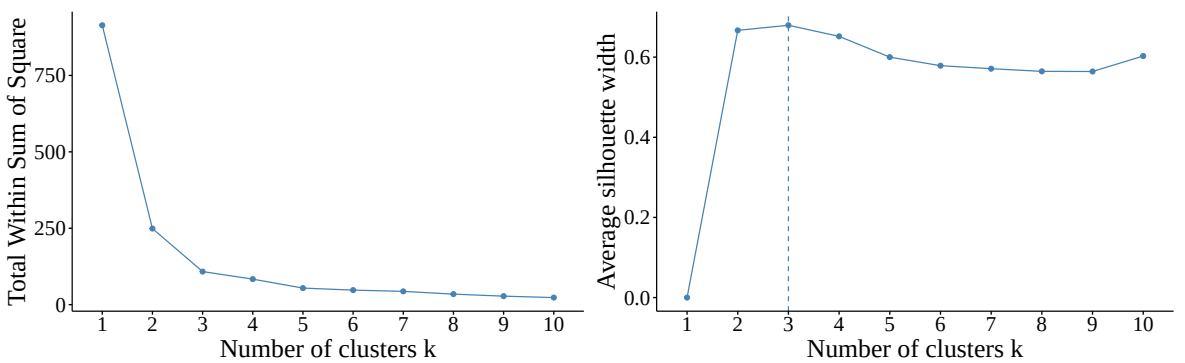
[20] Outliers are data-points that appear to be inconsistent with the rest of the data. For instance, in a scatter plot, outliers would be settled far away from their neighbourhood. In this study, outliers were detected using a distance-based approach (Angiulli et al. 2009; Knorr and Ng 1998; Orair et al. 2010; Ramaswamy et al. 2000; see Vinces et al. 2025 for a recent review of clustering based outlier detection techniques). To this effect, a

outliers, we could exclude at-chance participants, e.g. participants accepting or rejecting a condition 3 times out of 6, or isolated participants with no or few neighbours.



(a) Elbow curve (WCSS) **(b)** Silhouette score

Figure 8: Optimal number of clusters for simple disjunction in the adult dataset.



(a) Elbow curve (WCSS) **(b)** Silhouette score

Figure 9: Optimal number of clusters for simple disjunction in the child dataset.

The properties of each cluster in the adult dataset are reported in Table 15 and plotted in Figure 10. The cluster analysis revealed that adults were split between two groups. Both groups consistently accepted the *One Disjunct True* condition. However, the response pattern differed between the two groups in the *Two Disjuncts True* condition. The largest group consistently rejected this condition, which corresponded to an *exclusive* interpretation of simple disjunction. The other group, however, consistently accepted this condition, showing an *inclusive* interpretation.

Cluster	**Mean for each condition**		**Number of participants**	
	One Disjunct True	Two Disjuncts True	With outliers	Without outliers
Exclusive	5.87	0.2	65	60
Inclusive	5.75	5.5	8	8

Table 15: Mean score (rounded) of the two critical conditions in simple disjunction for each cluster in the adult dataset.

threshold was computationally defined (*[maximum distance − minimum distance] / 2*; Barai (Deb) and Dey 2017). Every data point whose distance from the centre of its cluster was above the threshold was considered as an outlier.

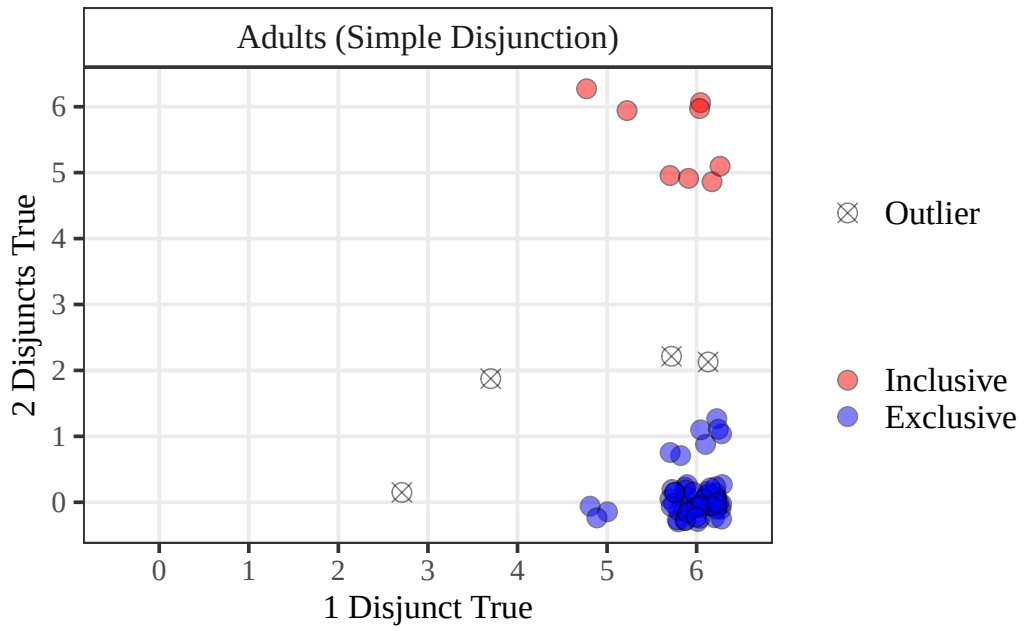


Figure 10: Scatter plot of the two clusters in the adult dataset for simple disjunction.

The properties of the clustered children dataset are reported in Table 16 and plotted in Figure 11. The cluster analysis revealed that, unlike adults, children are divided into three groups, two of which matched the adult ones. First, like adults, the largest group is composed of participants consistently accepting the *One Disjunct True* condition and rejecting the *Two Disjuncts True* condition, which is the adult-like *exclusive* interpretation. Second, another group consistently accepted both the *One Disjunct True* and the *Two Disjuncts True* conditions, corresponding to the *inclusive* interpretation. Finally, a subset of children consistently rejected the *One Disjunct True* condition but accepted the *Two Disjuncts True* condition, which corresponds to a *conjunctive* interpretation of disjunction. Notice that the mean age for each cluster varies. Both the *inclusive* children (M = 5;5, range = 3;7–7;7) and the *conjunctive* children (M = 5;8, range = 4;2–7;10) were younger than the *exclusive* children (M = 6;10, range = 4;9–8;3).

Cluster	**Mean for each condition**		**Number of participants**	
	One Disjunct True	Two Disjuncts True	With outliers	Without outliers
Exclusive	5.66	0.53	47	44
Inclusive	4.6	5.25	20	15
Conjunctive	0.71	5.65	17	16

Table 16: Mean score (rounded) of the two critical conditions in simple disjunction for each cluster in the children dataset.

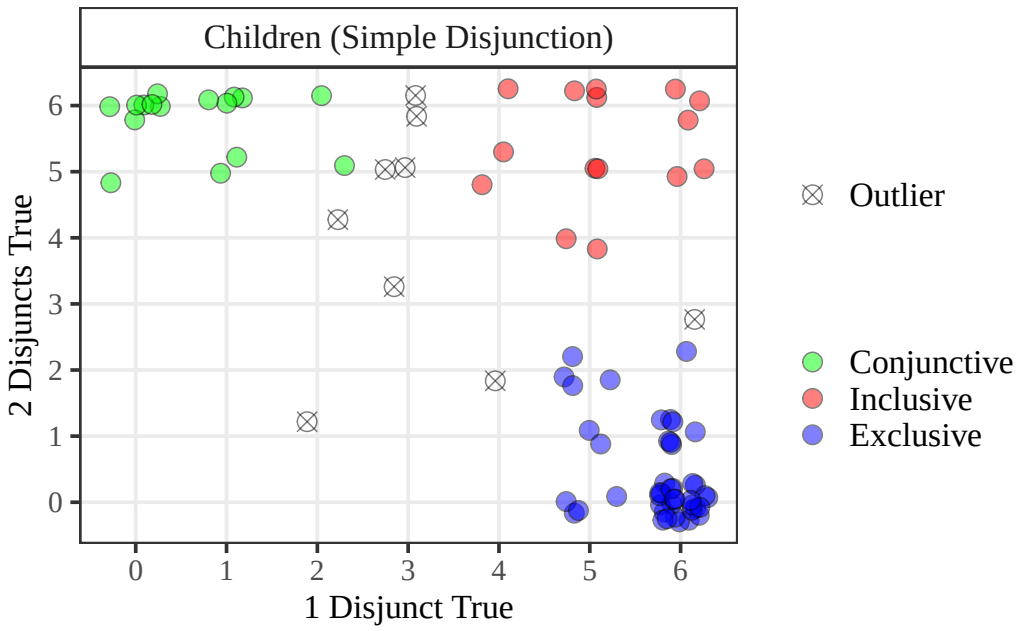
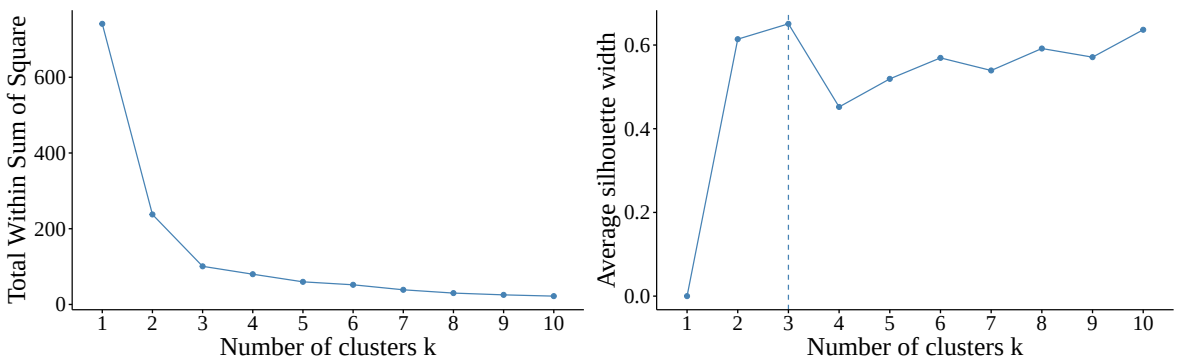


Figure 11: Scatter plot of the three clusters in the children dataset for simple disjunction.

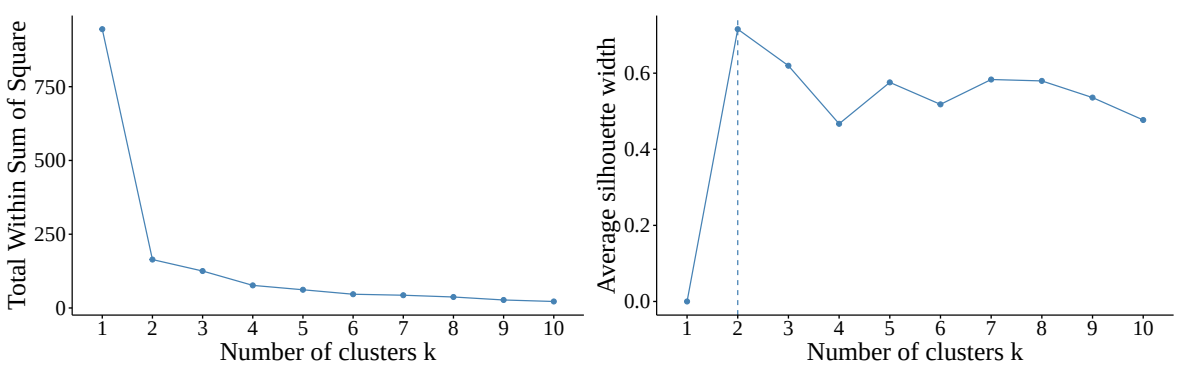
6.2.3 Negated disjunction cluster analysis

To determine the optimal number of clusters in negated disjunction, the same method as in Section 6.2.2 was adopted. For adults, the optimal number of clusters is three, as shown Figure 12. For children, the optimal number of clusters is two, as shown in Figure 13.



(a) Elbow curve (WCSS) **(b)** Silhouette score

Figure 12: Optimal number of cluster for negated disjunction in the adult dataset.



(a) Elbow curve (WCSS) **(b)** Silhouette score

Figure 13: Optimal number of cluster for negated disjunction in the child dataset.

As in the previous section, an anomaly detection algorithm has been run to identify outliers in each dataset.[21]

The cluster analysis revealed that adults are split between three groups in negated disjunction. The characteristics of the three adult clusters are given in Table 17 and plotted in Figure 14. The largest group corresponds to participants who accepted the *One Disjunct True* condition and rejected the *No Disjunct True* condition, which matches the *exclusive* interpretation. In contrast, the second group is composed of participants who accepted both conditions, which corresponds to the *not both* interpretation. Finally, the third group showed the opposite behaviour of the first group. These participants consistently rejected the *One Disjunct True* condition but accepted the *No Disjunct True* condition, that is a *neither...nor* interpretation.

Cluster	**Mean for each condition**		**Number of participants**	
	No Disjunct True	One Disjunct True	With outliers	Without outliers
Exclusive	1.02	5.25	44	34
Not both	5.41	4.91	12	10
Neither...nor	5.70	0.58	17	14

Table 17: Mean score (rounded) of the two critical conditions in negated disjunction for each cluster in the adult dataset.

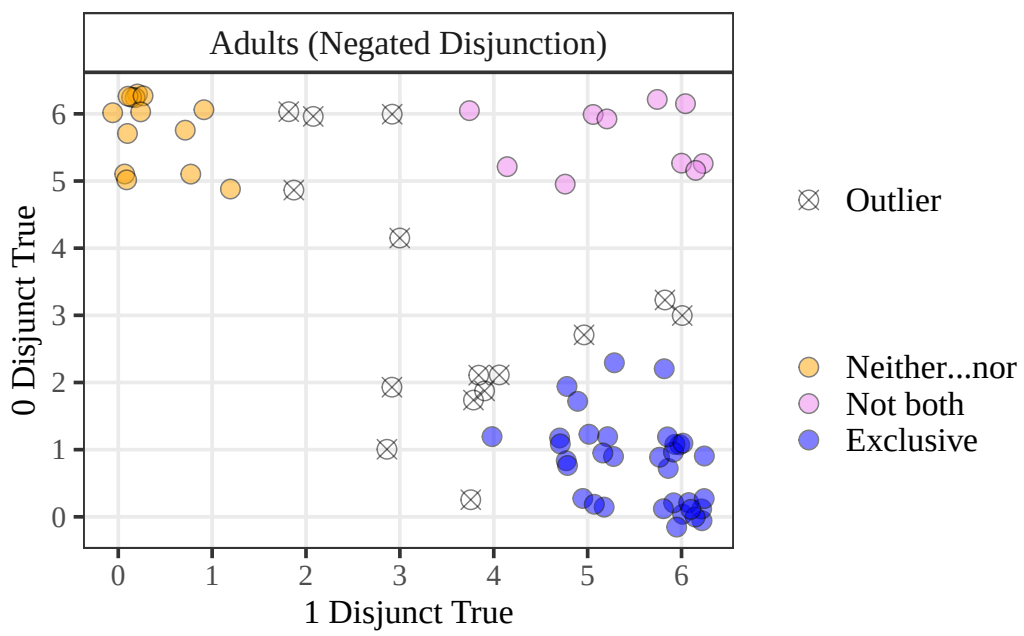


Figure 14: Scatter plot of the three clusters in the adult dataset for negated disjunction.

[21] Notice that the anomaly detection algorithm was too conservative for the adult dataset, leading to the exclusion of obvious consistent participants (e.g. accepting a condition 6 times out of 6). We could either run a different clustering algorithm such as k-medoids (Kaufman & Rousseeuw, 1990) or relax the threshold in the anomaly detection computation so that consistent participants are not mistakenly considered as outliers. We chose to keep the k-means algorithm and relax the anomaly detection threshold to ensure the consistency of the clustering method between children and adults. The threshold was relaxed to a point it did no longer exclude obvious consistent participants.

The characteristics of the two child clusters are given in Table 18 and plotted in Figure 15. In contrast to the adults, the children only divided into two groups. The first group matched the *exclusive* interpreters in the adult dataset. These children consistently accepted the *One Disjunct True* condition and rejected the other condition. The second group corresponded to *neither...nor* interpreters, which, contrary to the adults, was the largest group. Moreover, unlike their response patterns in simple disjunction, there is no difference in mean age between the two child groups in negated disjunction, both the *exclusive* interpreters (M = 6;5, range = 4;1–8;3) and the *neither...nor* interpreters (M = 6;3, range = 3;6–8;5) showing a mean age of six.

Cluster	Mean for each condition		Number of participants	
	No Disjunct True	One Disjunct True	With outliers	Without outliers
Exclusive	1.39	5.29	38	30
Neither...nor	5.54	0.78	46	40

Table 18: Mean score (rounded) of the two critical conditions in negated disjunction for each cluster in the child dataset.

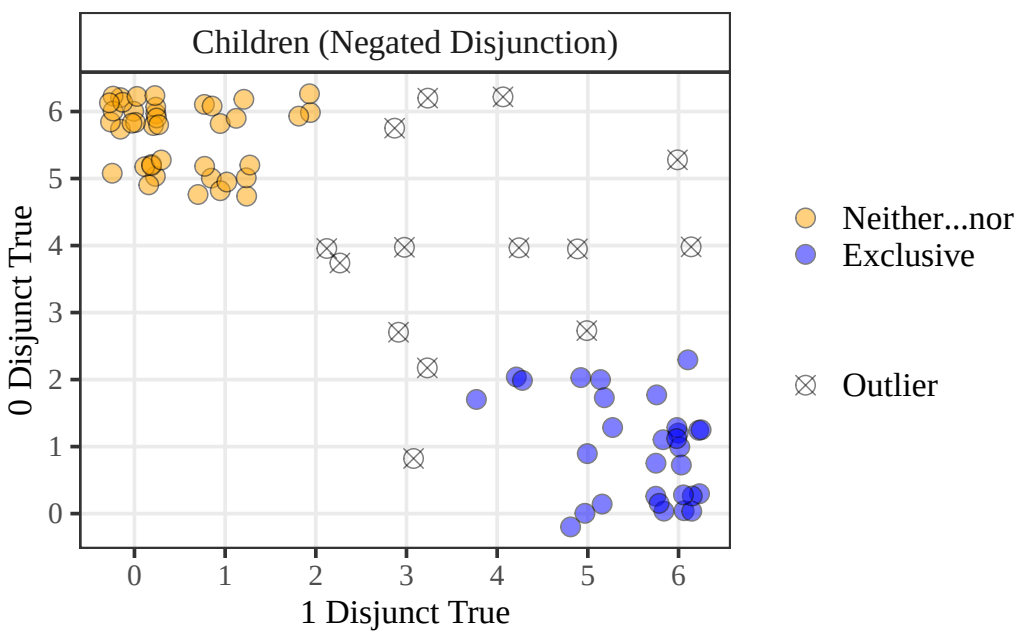


Figure 15: Scatter plot of the two clusters in the child dataset for negated disjunction.

6.2.4 Combining simple and negated disjunction clusters

Given that our primary objective was to investigate the interpretation of simple and negated disjunction within the same speakers, we combined the response patterns of both contexts for each participant. Tables 19 and 20 report the combined interpretation patterns for adults and children, respectively.

		Negated Disjunction			
		Exclusive	Not both	Neither...nor	Outlier
Simple Disjunction	Exclusive	34	3	13	11
	Inclusive		5	1	2
	Conjunctive				
	Outlier		2		2

Table 19: Contingency table crossing the responses patterns of adult participants for simple and negated disjunction. Each cell indicates the number of participants with the corresponding pair of interpretations. Grey cells correspond to unattested patterns.

		Negated Disjunction			
		Exclusive	Not both	Neither...nor	Outlier
Simple Disjunction	Exclusive	27		11	6
	Inclusive	3		8	4
	Conjunctive			16	
	Outlier			5	4

Table 20: Contingency table crossing the responses patterns of child participants for simple and negated disjunction. Each cell indicates the number of participants with the corresponding pair of interpretations. Grey cells correspond to unattested patterns.

Table 19 reveals two systematic patterns of interpretation for adults, thus identifying two subgroups. Both share the *exclusive* interpretation of simple disjunction, but they differ for negated disjunction. The largest group (n = 34) also showed the *exclusive* interpretation of negated disjunction, consistent with previous findings for French that disjunction is interpreted above negation (Pagliarini et al. 2022; see also Chapter 4). The other group (n = 13) consistently showed a *neither...nor* interpretation. There were a few other consistent interpretation patterns but these were scarcer. For instance, some participants who showed a *not both* interpretation in negated disjunction either showed an *exclusive* interpretation (n = 3) or an *inclusive* interpretation (n = 5) in simple disjunction.

Table 20 identifies four systematic response patterns. There were two subsets of children who exhibit adult-like behaviour by adopting one of the two main adult interpretive patterns: an *exclusive* interpretation for simple disjunction and either an *exclusive* interpretation (n = 27) or a *neither...nor* interpretation (n = 11) for negated disjunction. The other two systematic response patterns were non-adult-like. These children gave a *neither...nor* interpretation for negated disjunction and either showed an *inclusive* interpretation (n = 8) or a *conjunctive* interpretation (n = 16) in simple disjunction. An additional interpretive pattern was observed in a handful of participants (n = 3) who showed an *inclusive* interpretation for simple disjunction, but, unexpectedly, an *exclusive* interpretation for negated disjunction. In contrast to the other four, this pattern was not predicted.

6.3 Analysis of the age in the children

In order to provide a more accurate understanding of the variation within children and to investigate whether age is a significant predictor, two generalised mixed effects models were

run on the children, one for each type of disjunctive statement. Each model structure followed the same logic as in Section 6.1: the binary responses from participants (yes/no) were regressed against the relevant critical conditions (*No Disjunct True*, *One Disjunct True* or *Two Disjuncts True*) and Age in Months. Participant and Item-level random effects were included to reflect individual variations. In addition, a random slope for the Number of Disjunct True was added to the Participant-level random effect. The coefficients of the models for simple and negated disjunction are reported in Table 21 and Table 22, respectively.

Predictor	**Estimate (β)**	**SE**	z	p
Intercept	2.31	0.44	5.27	$< .001^{***}$
Two Disjuncts True	−3.16	0.83	−3.82	$< .001^{***}$
Age in Months	1.25	0.40	3.14	$.001^{**}$
Two Disjuncts True × Age in Months	−3.58	0.83	−4.32	$< .001^{***}$

Table 21: Coefficients for simple disjunction; Formula. *answer ~ nb_of_disjunct_true * Age_in_Months + (1 + nb_of_disjunct_true | participants) + (1 | items)*

Predictor	**Estimate (β)**	**SE**	z	p
Intercept	0.91	0.33	2.80	$.005^{*}$
One Disjunct True	−1.15	0.67	−1.71	.087
Age in Months	−0.26	0.31	−0.82	.411
One Disjunct True × Age in Months	0.54	0.67	0.82	.411

Table 22: Coefficients for negated disjunction. Formula: *answer ~ nb_of_disjunct_true * Age_in_Months + (1 + nb_of_disjunct_true | participants) + (1 | items)*

The models revealed a sharp contrast between simple disjunction and negated disjunction. In simple disjunction, the Number of Disjuncts True was a significant predictor of children's responses alongside the Age, and their interaction. In comparison, none of these fixed effects were significant in negated disjunction. To detect whether the absence or presence of the effect of age concerns the two critical conditions, only one, or none of them, we computed estimated marginal means of linear trends using the *emtrends()* functions from the *emmeans* package (Lenth, 2025) in R.

Age trends for each critical condition of simple disjunction are reported in Table 23 and illustrated in Figure 16. For the *One Disjunct True* condition, the age trend was positive, indicating that the number of yes-responses significantly increased with age (first panel of Figure 16). Conversely, the age trend for the *Two Disjuncts True* condition was negative, showing that the number of yes-responses significantly decreased with age for this condition (second panel of Figure 16). The third panel repeats the trend lines and shows that the tendency to reject the *One Disjunct True* condition and to accept the *Two Disjuncts True* condition reverses around the age of 5 (60 months).

Predictor	Age trend (β)	SE	z	p
One Disjunct True	0.08	0.03	3.14	.002*
Two Disjuncts True	−0.15	0.04	−4.41	< .001***

Table 23: Linear trends of age for each critical condition in simple disjunction.

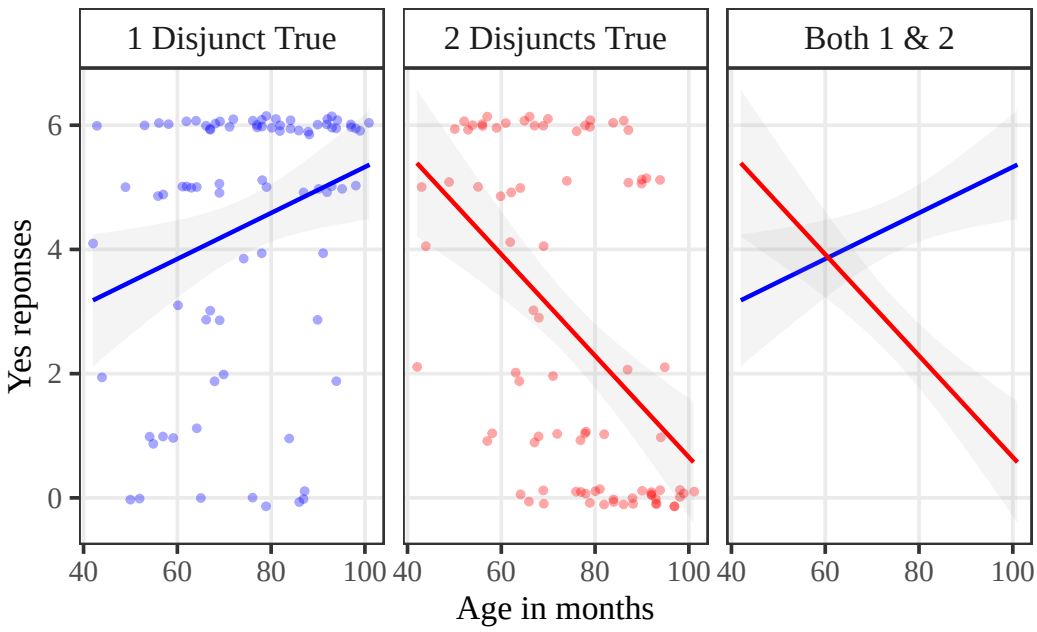


Figure 16: Regression lines of the number of yes-responses for each condition for simple disjunction across age (expressed in months). Each dot corresponds to an individual (jitter added to ease visualisation).

Age trends for each critical condition of negated disjunction are reported in Table 24 and illustrated in Figure 17. For the *No Disjunct True* condition, the age trend was negative, indicating that the number of yes-responses decreased with age (first panel of Figure 16). Conversely, the age trend for the *One Disjunct True* condition was positive, showing that the number of yes-responses increased with age for this condition (second panel of Figure 17). However, neither of these two age trends was significant, corroborating the absence of effect for the age in the model reported in Table 22. Contrary to Figure 16, the third panel shows that the two lines in Figure 17 never cross. In sum, there is no age effect in negated disjunction.

Predictor	Age trend (β)	SE	z	p
No Disjunct True	−0.02	0.02	−0.82	.410
One Disjunct True	0.02	0.02	0.76	.445

Table 24: Linear trends of age for each critical condition in negated disjunction.

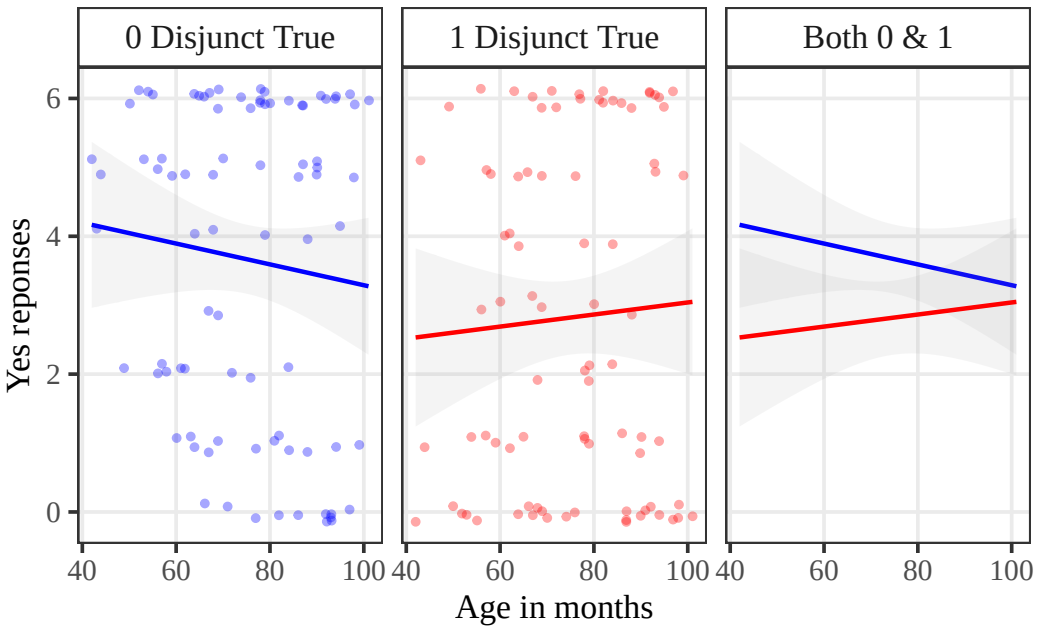


Figure 17: Regression lines of the number of yes-responses for each condition for negated disjunction across age (expressed in months). Each dot corresponds to an individual (jitter added to ease visualisation).

7 General discussion

Section 7.1 presents a summary of the main findings. Section 7.2 discusses the interpretation of the adults, while Section 7.3 turns to the child data, addressing both their interpretation in isolation (simple and negated disjunction) and their consistency across contexts. Building on these findings, Section 7.4 discusses the developmental sources of children's interpretations of negated disjunction.

7.1 Summary of findings

The objectives of the study were twofold. First and more importantly, we asked whether children's performance on both simple and negated disjunctive statements is related. Specifically, we proposed that a learner's developing grammar can be predicted by the interplay of three components: whether pragmatic enrichment has occurred (via the insertion of the *Exh* operator), the nature of the set of relevant alternatives and the scope of disjunction relative to negation. To address this question, both simple and negated disjunctive statements were investigated using the same setup and the same participants. Three sets of predictions were made: (i) a *conjunctive* reading in simple disjunction should systematically co-occur with a *neither...nor* reading in negated disjunction; (ii) an *exclusive* reading in negated disjunction should systematically co-occur with an *exclusive* reading in simple disjunction; and (iii) an *inclusive* reading in positive contexts could either be associated with a *not both* or a *neither...nor* interpretation in negated disjunction, depending on the scope of disjunction with respect to negation.

Second, we investigated which readings of negated disjunctive statements French adults could access and whether there was variation among them, such as the group of speakers reported in Lungu et al. (2021) and Larralde et al. (2021) who could access the *neither...nor* interpretation, and whether children show the same variation. For children, a key question was how to distinguish a genuinely adult-like *neither...nor* interpretation from one arising

for non-adult-like reasons. To answer this, we took performance on simple disjunction as a diagnostic of adult-like competence. We considered children adult-like if they had an *exclusive* reading in simple disjunction and a *neither...nor* reading in negated disjunction. Proceeding so permitted us to identify an adult-like group of children who showed an *exclusive* reading in simple disjunction and a *neither...nor* reading in negated disjunction.

Table 25 below summarises all possible interpretation patterns across both groups, along with participant counts for each combination. Note that this table only includes consistent participants according to our cluster analysis (see Section 6.2.4 for a table that includes all participants, including outliers).

Status	Simple Disjunction	Negated Disjunction	Adults	Children
Expected	Exclusive	Exclusive	34	27
	Exclusive	Neither...nor	13	11
	Inclusive	Not both	5	
	Inclusive	Neither...nor	1	8
	Conjunctive	Neither...nor		16
Unexpected	Exclusive	Not both	3	
	Inclusive	Exclusive		3
Unattested	Conjunctive	Not both		
	Conjunctive	Inclusive		

Table 25: Number of consistent participants per group and interpretation pattern. (Adults: N = 56; Children: N = 65). Grey cells indicate the absence of participants for a given combination.

Starting with the second question about the interpretation of negated disjunction, there was indeed variation in the adults. There were two main groups with distinct preferences: one group systematically showed an *exclusive* interpretation, while the other population exhibited a *neither...nor* interpretation. Furthermore, note that some adults appeared not to calculate the exclusivity inference, as evidenced by *inclusive* and *not both* readings. The adult results are discussed in more detail in Section 7.2.

The results from the children showed that the three predicted patterns outlined in Section 4 were all attested, supporting the hypothesis that the mastery of disjunction carries over across simple and negated contexts. In simple disjunction, unlike adults who consistently adopted the *exclusive* interpretation, more than half of the children exhibited a non-adult-like interpretation, either the *inclusive* or the *conjunctive* reading. As predicted, the *conjunctive* reading was always paired with the *neither...nor* reading in negated disjunction; this was also largely true for the *inclusive* reading. Children who showed an *exclusive* interpretation in simple disjunction, which we took as the hallmark of a truly adult-like interpretation, showed the same variation as adults in the case of negated disjunction. The distribution of the two readings was also similar across groups, with roughly one-third of these children and adults showing the *neither...nor* reading, and two-thirds the *exclusive* reading. Moreover, the *exclusive* reading in negated disjunction was (almost) always accompanied by the *exclusive* reading in simple disjunction. Finally, note that no child produced a *not both* interpretation. The children's results and the corresponding explanations are discussed in more detail in Section 7.3.

7.2 Interpretation patterns in adults

The distribution of the adult responses for simple and negated disjunction aligned with our expectations, that adults were predicted to divide between two groups with distinct preferences. A majority of adults accepted only the *One Disjunct True* condition in both contexts and rejected the *Two Disjuncts True* condition in simple disjunction and the *No Disjunct True* condition in negated disjunction. In other words, these participants showed an *exclusive* interpretation in both contexts. Another group of participants behaved similarly in simple disjunction but differed in negated disjunction. These participants consistently accepted the *No Disjunct True* condition and rejected the *One Disjunct True* condition, corresponding to a *neither...nor* reading.

These results corroborate previous findings (Lungu et al., 2021; Larralde et al., 2021) that the *neither...nor* interpretation is accessed in French. Crucially, our design furthermore allowed identification of individual patterns. These revealed a stronger empirical generalisation: there were two distinct adult populations in French, each preferring a different scope configuration for disjunction with respect to negation. One group systematically interpreted disjunction above negation (OR > NEG), consistent with treating French disjunction *ou* as a positive polarity item (+PPI; Spector 2014; Nicolae 2017). The other group consistently assigned low scope to disjunction (NEG > OR), producing a *neither...nor* reading as per De Morgan's laws. For these speakers, disjunction could not be a positive polarity item (−PPI)[22].

These findings carry important implications at two levels. First and most importantly, this variation is especially relevant for language acquisition, as it reveals that the *neither...nor* reading is a valid target reading in French, a possibility that was previously ruled out for this language (Pagliarini et al., 2022). Second, it raises theoretical questions about the status of disjunction in French, in particular, whether the positive polarity parameter can be maintained. If disjunction is not a positive polarity item, it is free to take scope either above or below negation. This means that a language in which disjunction is not a positive polarity item should, in principle, allow for the *exclusive* and the *neither...nor* interpretations. The adult data suggest this is indeed the case for French. The fact that the two interpretations are distributed across two different groups suggests individual preferences. Importantly, the French distribution is different from the preference for the *neither...nor* interpretation in other languages where disjunction is claimed to not be a positive polarity item, such English (Szabolcsi, 2002; Chierchia et al., 2004) or Dutch (Szabolcsi, 2002; Pagliarini et al., 2022). These results call into question Szabolcsi's (2002) cross-linguistic positive polarity parameter that might need to be reconsidered to account for the French case. We will argue in Chapter 4 that these results can be explained if the parameter operates at the individual level (i.e., between participants).

One remaining question is to determine whether the interpretative preference is rigid (i.e., participants stick to their preferred interpretation at all cost) or more flexible (i.e., participants can navigate between interpretations). We show in Chapter 4 that switching from one interpretation to the other might not happen freely, but can be facilitated by disambiguating factors such as prosody (see also van Hout et al., 2024).

Finally, a minority of the adults did not compute the exclusivity inference in one or both contexts (9 out of 56 adults). Five adults showed an *inclusive* reading in simple disjunction and

[22] Notice, however, that if disjunction is not a positive polarity item, it is, technically speaking, free to take scope either above or below negation. This means that a language in which disjunction is not a PPI should, in principle, equally allow for *exclusive* and *neither...nor*. However, empirically, in languages where disjunction has been reported not to be a PPI, such as English, Dutch, or Korean (Szabolcsi, 2002; see Table 3 in Section 2.2.2), the *neither...nor* interpretation is the most attested interpretation.

a *not both* reading in negated disjunction. One additional adult showed an *inclusive* reading for simple disjunction but a *neither...nor* interpretation for negated disjunction, likely due to interpreting disjunction within the scope of negation. The remaining three participants appeared to be inconsistent, computing the exclusivity inference for simple but not for negated disjunction. Although these patterns are marginal, they raise the question of why some adults fail to show pragmatic enrichment. One plausible explanation is that these adults derived the implicature but subsequently cancelled it. We speculate that these speakers may have been pragmatically tolerant, accepting the use of a disjunctive statement as a good-enough description of a scenario that is generally ruled out by pragmatic reasoning (e.g. the *Two Disjuncts True* condition in simple disjunction). We leave it to future research to explore why a small subset of adults might adopt such a strategy.

7.3 Interpretation patterns in children

7.3.1 Simple disjunction

In simple disjunction, there were two non-adult-like interpretations, *inclusive* and *conjunctive*, and the adult-like *exclusive* interpretation. These results partly align with findings from previous studies which identified these two non-adult-like patterns as well (Singh et al., 2016; Tieu et al., 2017). However, our study found a higher proportion of exclusive interpreters than the aforementioned studies. This is likely due to the higher mean age range. We tested 96 children and included 84 in the final analysis, ranging from 3;6 to 8;5 years old, with a mean age of 6;3. In contrast, Singh et al. tested 63 children and included 31 in their analysis (range: 3;6−6;4, mean age: 4;11), while Tieu et al. (2017) tested 28 French-speaking children (range: 3;7−6;6, mean age: 4;5) and 18 Japanese children (range: 4;7−6;6, mean age: 5;5). As shown in Section 6.3, age plays a role: with increasing age, children were more likely to reject the *Two Disjuncts True* condition and accept the *One Disjunct True* condition. Another possibility is that the methodological improvements in our study, particularly the inclusion of a felicitous falsifying condition, as recommended by Skordos et al. (2020), may have contributed in increasing the number of *exclusive* interpreters.

In line with the predictions laid out in Section 4, all attested interpretations of simple disjunction can be accounted for by considering both whether pragmatic enrichment has occurred (via the insertion of the *Exh* operator) and the presence or absence of the conjunctive alternative in the relevant set of alternatives. Table 26 summarises the three grammars arising from our results.

Grammar	***Exh***	**Set of alternatives**	**Interpretation**
Complete scale	1 round of *Exh*	Complete set $\{P, Q, P \wedge Q\}$	Exclusive
No scalar alternative	2 rounds of *Exh*	Incomplete set $\{P, Q\}$	Conjunctive
Inclusive			Inclusive

Table 26: Possible grammars leading to the different interpretations of simple disjunction.

The *Complete scale grammar* corresponds to children who applied the exhaustification procedure and moreover generated the scalar conjunctive alternative, resulting in the *exclusive* interpretation. The *No scalar alternative* grammar corresponds to children who can apply

the exhaustification procedure in an adult-like-manner but lack the conjunctive alternative as initially proposed by Singh et al. (2016). This grammar yields the *conjunctive* interpretation of simple disjunction. Finally, the *Inclusive* grammar posits that children do not engage in any form of pragmatic enrichment. As a result, these children interpret disjunction inclusively. Notice that a concurrent explanation is that these *inclusive* children behaved adult-like, first generating the exclusivity inference and then cancelling it. However, child *inclusive* interpreters are twice as numerous as adult *inclusive* ones (15 children vs. 8 adults; see Table 25), suggesting that the cancellation approach is insufficient to account for all children showing this interpretation.

On the *inclusive* interpretation, Singh et al. (2016) write "'*Logicians'* [i.e. inclusive] *are those individuals – child or adult – who choose not to exhaustify.*" and do not commit to the claim that *inclusive* children have not acquired a pragmatic enrichment mechanism like exhaustification. Critically, we align with their view: at present, we have no way of determining whether these children in fact possess such a mechanism but simply did not make use of it, or whether they have yet to acquire it. It is worth noting that the *inclusive* reading was explained in different terms in Tieu et al. (2017; p.144). For them, failure to access the conjunctive scalar alternative means that children do not perform any pragmatic enrichment and are therefore left with the logical, *inclusive* meaning of disjunction. However, this explanation overlooks a crucial aspect of Singh et al.'s (2016) proposal: the absence of the conjunctive alternative from the set of innocently excludable alternatives does not prevent the exhaustification procedure from applying. To the contrary, lacking this alternative automatically generates the *conjunctive* interpretation (see Section 2.1.3). Thus, the absence of the conjunctive alternative alone cannot explain how an *inclusive* interpretation arises and further assumptions are needed (e.g. these children are unable to insert the *Exh* operator into the structure).

7.3.2 Negated disjunction

Turning next to the findings for negated disjunction, children were divided into two groups: *neither...nor* and *exclusive* interpreters. In this section, we discuss these two interpretive patterns and show how they can arise depending on whether children perform pragmatic enrichment (via the insertion of the *Exh* operator), the set of relevant alternatives and the scope of disjunction. We distinguish the three possible grammars in Table 27 and discuss them in turn.

Grammar	***Exh***	**Set of alternatives**	**Scope**	**Interpretation**
Complete scale + Wide scope	1 round of *Exh*	Complete set $\{\neg P, \neg Q, \neg P \wedge \neg Q\}$	OR > NEG	Exclusive
Narrow scope			NEG > OR	Neither...nor
No scalar alternative + Wide scope	2 rounds of *Exh*	Incomplete set $\{\neg P, \neg Q\}$	OR > NEG	Neither...nor

Table 27: Possible grammars leading to different interpretations of negated disjunction.

In the *Complete scale + Wide Scope grammar*, children interpret disjunction as taking scope over negation and apply the exhaustification procedure with respect to a complete set of alternatives (first row of Table 27), yielding an *exclusive* interpretation. This grammar is the target adult-like grammar for French. In the *Narrow scope* grammar, disjunction is interpreted below negation (second row of Table 27), yielding a *neither...nor* interpretation. This scope configuration may stem from a genuine preference for this scope, or alternatively

from children adhering to the Semantic Subset Principle (Crain et al. 1994; see Section 2.2.3). In Section 7.4, we show that this principle poses a learnability issue and we argue therefore that it should be discarded. Furthermore, we propose that the *neither...nor* reading may also reflect a *No scalar alternative + Wide Scope grammar*, in which children interpret disjunction above negation and apply an adult-like exhaustification procedure over a set of alternatives that lacks the conjunctive alternative (third row in Table 27, see Section 2.2.4 for the derivation).

Note that the *not both* interpretation was not attested in the children's data. Recall from Sections 3 and 4, however, that this interpretation could reflect a grammar on which children interpret disjunction above negation but do not perform any pragmatic enrichment. One plausible explanation for the absence of the *not both* reading may lie in the developmental trajectory of negated disjunction. Suppose a trajectory in which children initially do not produce enriched meanings and interpret disjunction below negation (e.g. the Narrow scope grammar). This raises the question of which component develops first: scope or pragmatic enrichment. If children learn first that disjunction can scope above negation, then we would have expected *not both* interpreters who do not produce yet pragmatically enriched meanings. As this was not the case, we suggest that children may learn to produce such meanings first, and then learn that disjunction can scope above negation. Under such a trajectory, we would never expect the *not both* interpretation to arise. The reason is that when disjunction scopes above negation, the *not both* interpretation is automatically strengthened to either the *neither...nor* or the *exclusive* interpretation, depending on whether children know that disjunction forms a scale with conjunction. In Section 7.4.3, we propose an alternative explanation which does not rely on the developmental trajectory but instead on a preference to resolve as much ignorance as possible.

7.3.3 Interpreting disjunction across contexts

In this section, we offer an explanation for every combination of interpretation patterns predicted by the hypothesis that the development of simple and negated disjunction goes hand in hand (see Sections 3 and 4). Table 28 summarises the four possible grammars we were able to tease apart from the results.

Grammar	*Exh*	Set of alternatives	Scope	Simple disjunction	Negated disjunction
#1	1 round of *Exh*	Complete set $\{P, Q, P \wedge Q\}$	OR > NEG	Exclusive	Exclusive
#2	1 round of *Exh*	Complete set $\{P, Q, P \wedge Q\}$	NEG > OR	Exclusive	Neither...nor
#3	2 rounds of *Exh*	Incomplete set $\{P, Q\}$	NEG > OR OR > NEG	Conjunctive	Neither...nor
#4			NEG > OR	Inclusive	Neither...nor

Table 28: Predicted patterns for simple and negated disjunction, depending on the nature of the set of alternatives, whether pragmatic enrichment occurred and the scope of disjunction with respect to negation. Grammars: 1 = *Complete scale + Wide Scope*; 2 = *Complete scale + Narrow scope*; 3 = *No scalar alternative*; 4 = *Inclusive + Narrow scope*

The *Complete scale* grammars (#1 and #2 in Table 28) accounts for two adult-like patterns: both share the *exclusive* reading in simple disjunction; one is paired with the

exclusive interpretation in negated disjunction (*Wide scope*) and the other with the *neither...nor* interpretation (*Narrow scope*). For the *Complete scale + Narrow scope* grammar, the *neither...nor* reading results from a genuine adult-like preference for this interpretation. Children with the *Complete scale* grammars consistently produce enriched meanings and know that disjunction and conjunction form a scale, as revealed by the *exclusive* reading in simple contexts.

Moreover, using the interpretation of simple disjunction as an indicator of (non-)adult-likeness in negated disjunction permitted us to tease apart genuine adult-like *neither...nor* children from non-adult-like ones who arrive at this reading for non-adult-like reasons. Importantly, the distribution of the two target readings (*exclusive* and *neither...nor*) between the two groups of adult-like children mirrors the adult distribution. Of the 38 children who gave an *exclusive* reading for simple disjunction, 27 also gave an *exclusive* reading in negated disjunction, while 11 gave a *neither...nor* reading. Similarly, among adults, 34 exhibited an *exclusive* reading and 14 gave a *neither...nor* reading, that is approximately 70% of each group. This parallel suggests that the two adult varieties, which vary with respect to the scope of disjunction, are also active in children. But, this finding raises an important issue for Larralde et al. (2021) and Pagliarini et al. (2022), who both investigated the acquisition of negated disjunction in French. The conclusion that all the children who had a *neither...nor* reading were non-adult-like is premature. To the contrary, the present findings suggest that some of these children may have been misclassified as non-adult-like, while, in fact, they were genuine adult-like interpreters.

In the *No scalar alternative* grammar (#3 in Table 28, children gave a *conjunctive* interpretation for simple disjunction and a *neither...nor* interpretation for negated disjunction. Both interpretations stem from the same underlying source: these children can perform pragmatic enrichment but lack access to the conjunctive alternative (as originally argued by Singh et al. 2016, for simple disjunction), assuming that disjunction is interpreted above negation (see Section 2.2.4 for the derivation). Importantly, the pragmatic enrichment procedure yielding the *neither...nor* reading is structurally parallel to that which produces the *conjunctive* interpretation in simple disjunction (see Section 2.1.3). Yet, a limitation of this study is that we cannot distinguish this scenario from the possibility that some children also interpret disjunction below negation, for example, due to a genuine preference for this scope configuration, consistent with adult variation in French.

Finally, in the *Inclusive + Narrow scope* grammar (#4 in Table 28), children showed an *inclusive* interpretation of simple disjunction and a *neither...nor* interpretation of negated disjunction. The exclusivity inference was not calculated in simple disjunction, and disjunction was interpreted below negation in negated disjunction.

Notice that a handful of children exhibited an unexpected pattern that does not correspond to any of the grammars listed in Table 28: they gave an *inclusive* interpretation for simple disjunction but an *exclusive* reading for negated disjunction. This pattern is inconsistent with the assumption that mastery of disjunction is uniform across contexts. If children can calculate the exclusivity inference for negated disjunction, they should also be able to do so for simple disjunction, and vice versa. However, this pattern is marginal, representing only three children in the entire sample. As we speculated for adults in Section 7.2, it is plausible that these children were pragmatically tolerant, accepting the use of a disjunctive statement to describe a scenario in which the lexical conjunctive alternative (i.e., *and*) would have been more appropriate (on pragmatic tolerance, see Katsos and Bishop 2011).

7.4 Developmental explanations for children's interpretations of negated disjunction

This section explores possible developmental explanations for children's interpretations of negated disjunction. In Section 7.4.1, we critically evaluate the Semantic Subset Principle and argue that it fails to account for several empirical observations, including variability across individuals. Section 7.4.2 presents the Semantic Subset Maxim, a more flexible candidate to replace the Semantic Subset Principle. Finally, in Section 7.4.3, we propose an alternative account which predicts *neither...nor* readings to arise as a consequence of a preference for interpretations that carry the least ignorance possible.

7.4.1 Limitations of the Semantic Subset Principle

To account for children's tendency to assign a *neither...nor* interpretation to negated disjunction, Goro and Akiba (2004) proposed that learners adhere to the Semantic Subset Principle (Crain et al., 1994). This developmental principle posits that when two interpretations stand in a subset-superset relation, children initially default to the interpretation that is true in the least range of circumstances (i.e., the subset interpretation). In the case of negated disjunction, the *neither...nor* interpretation (NEG > OR) is a subset of the *not both* interpretation (OR > NEG), and as such, is predicted to be the learner's default interpretation. In other words, in the course of language development, disjunction is predicted to be initially interpreted below the scope of negation according to the Semantic Subset Principle. Subsequently, the *not both* interpretation, which arises when disjunction scopes over negation, is expected to be acquired only after sufficient positive evidence for this reading becomes available. Such evidence would take the form of a negated disjunctive statement uttered felicitously in a context where only one disjunct is false, thus falsifying the *neither...nor* reading.

However, this account faces several challenges. First, there is a learnability problem: the required positive evidence appears to be absent from children's input. Sano et al. (2024), for example, conducted a corpus search on the Miyata and MiiPro corpora (Miyata, 2012) in the CHILDES database (MacWhinney, 2000) and did not find a single instance of a negated disjunctive statement directed to children. A parallel search in the French corpora returned nearly identical results, with only one relevant instance[23] in the York corpus (De Cat & Plunkett, 2002; Plunkett, 2002). However, in this case, illustrated in (49), the negated disjunctive statement clearly receives a *neither...nor* interpretation, and thus cannot constitute positive evidence for the *exclusive* interpretation.

(49) MOT: c'est pas pour du vrai hein (Léa, 2;11.18)
"but it's not for real, uh"
CHI: non je vais prendre une ch[//] un
"no, I will take a ch[//] a"
MOT: non tu n'as **pas** besoin d'un tabouret **ou** d'une chaise
"no, you don't need a stool or a chair"
MOT: non non
"no, no"
CHI: mais si parce que (.) c'est pour euh
"but yes because (.) it's for uh"

[23] We found three more occurrences in the Champaud corpus (Champaud, 1994), but these negated disjunctive statements appeared during a conversation between the parent and the researcher and were not specifically directed to the child.

In all, the relevant positive evidence appears to be low frequent or even non-existent (at least for Japanese and French). Then, how do children switch to the other interpretation in the absence of such evidence? One might attempt to rescue the Semantic Subset Principle by arguing, following Pagliarini et al. (2022), that languages like French offer an unambiguous *neither...nor* construction (e.g., French *ni...ni...* as in (50)), and that this form acts as a cue for associating the *neither...nor* reading with *ni...ni...*, leaving the *exclusive* reading for negated disjunction. However, this explanation is problematic. A corpus search in the French corpora of the CHILDES database revealed that such constructions are equally rare in children's input (at least for French). Moreover, this account also incorrectly predicts that speakers of languages like Spanish, which also has a *ni...ni...* construction, should not show the *neither...nor* interpretation in negated disjunctive statements, contrary to what is observed for adults (Lobina et al., 2023b; Becerra Zita et al., 2014).

(50) Liz a colorié ni la fleur ni l'arbre.
Liz AUX.PRS.3SG color.PART.PST *ni* the flower *ni* the.tree
Liz colored neither the flower nor the tree.

Second, the generalisation that children lack one of the two interpretations altogether is too strong. Several empirical findings showed that children can access the allegedly unavailable *exclusive* reading in languages where disjunction is analysed as a positive polarity item, including the current study. For instance, Pagliarini et al. (2018b) conducted two experiments investigating the interpretation of negated disjunctive statements in Italian among children aged 3 to 6 years. Their results revealed a bimodal distribution: one group of children consistently manifested the *neither...nor* interpretation, in line with the predictions of the Semantic Subset Principle, while another group consistently showed the adult-like *exclusive* reading.

Further evidence that children can access the *exclusive* reading alongside the *neither...nor* interpretation comes from Jing (2008). Examining the case of Mandarin Chinese, which allows disjunction to be interpreted above negation, Jing hypothesised that if children really adhered to the Semantic Subset Principle, they should only be able to access the *neither...nor* reading. By manipulating the Question under Discussion in her experiment (i.e. the main contextual element under consideration in the discourse; see Groenendijk and Stokhof 1984; Roberts 1996; Stalnaker 1978), Jing showed that children could access both interpretations, though the *neither...nor* reading remained the preferred one.

7.4.2 The Semantic Subset Maxim

To address the limitations of the Semantic Subset Principle, we adopt a weaker formulation, the Semantic Subset Maxim (Notley et al., 2012, 2016), given in (51). The Maxim retains the insight that children tend to prefer the stronger, subset reading, but crucially allows both readings to be available from the outset.

(51) **Semantic Subset Maxim**
"[...] within any given language, a sentence S containing two logical operators will always have two available interpretations, A and B. The child's task is to determine which of these interpretations is preferred in the local language. [...] The Semantic Subset Maxim enjoins children to initially favour the scope relationship that makes the sentence true in the narrowest range of circumstances, the subset reading."
(Notley et al., 2012; pp. 490-491)

Rather than assuming distinct grammars between children and adults, for which the range of

available interpretations of an ambiguous sentence is not the same, Notley et al. (2012) propose that children and adults share the same grammar in which both interpretations are available. For adults, one interpretation might be preferred over the other for independent reasons (e.g. a positive polarity parameter operating on disjunction) but the other interpretation remains available, though it may need some facilitating factors to arise (e.g. by a disambiguating context or by prosody as demonstrated in Chapter 4). For children, the Semantic Subset Maxim enjoins them to initially favour, *but not default to*, the interpretation that is true in the least range of circumstances, still allowing for the other interpretation to arise like adults. One of the main advantages of the Semantic Subset Maxim over the Semantic Subset Principle is that the other reading is part of children's grammar, and as such remains in principle accessible, while preserving the general observation that children prefer the strongest interpretation.

For negated disjunctive statements, the Semantic Subset Maxim predicts that children will prefer to interpret disjunction below the scope of negation, giving a *neither...nor* interpretation, that is logically stronger than the *not both* reading. Critically, however, the Semantic Subset Maxim still does not explain the complete absence of the *not both* interpretation. In the next Section, we propose an alternative explanation which get rid of a Semantic Subset approach while accounting for the prevalence of the *neither...nor* reading.

7.4.3 An alternative account: A preference for resolving as much ignorance as possible

The Semantic Subset Maxim (Notley et al., 2012) offers a more felicitous account than the Semantic Subset Principle (Crain et al., 1994) for children's preference for the *neither...nor* reading, as the learnability issue is not as critical in the Maxim as it is in the Principle. However, it remains insufficient, as it still predicts the *not both* reading to arise marginally, whereas this interpretation was never attested in our data. In this section, we propose a different approach, attributing the absence of the *not both* interpretation to a general preference for resolving as much ignorance as possible. As is well known, children dislike under-informative statements (Barner et al., 2011; Heredia Murillo, 2023; Katsos & Bishop, 2011; Huang & Snedeker, 2009; Noveck, 2001; among many others), of which disjunctive sentences carrying ignorance inferences are a subtype. Prior to any pragmatic enrichment, a wide scope negated disjunctive statement (OR > NEG) carries the ignorance inferences in (52). Conversely, a narrow scope negated disjunctive statement (NEG > OR) does not carry any ignorance inference: the speaker knows that both disjuncts are false.

(52) Liz did not color the flower or she did not color the tree.
   a. The speaker does not know whether Liz did not color the flower.
   b. The speaker does not know whether Liz did not color the tree.
   c. The speaker does not know whether Liz colored neither the flower nor the tree.

As a result, children are predicted to initially prefer the scope generating the *neither...nor* reading, since no ignorance arises in such a case. On this account, the *not both* interpretation is absent not because the corresponding scope configuration is ruled out by the Semantic Subset Principle or rendered marginal by the Semantic Subset Maxim, but rather because of the excessive amount of uncertainty it conveys. Importantly, this proposal subsumes the main prediction made by the Semantic Subset approach for negated disjunction, namely, that children appear to default to the *neither...nor* reading, thereby eliminating the need for the principle itself to explain children's interpretation of such statements. Eventually, note that this proposal naturally extends to simple disjunctive statements. The enrichment procedure leading to the conjunctive interpretation eliminates all ignorance inferences, providing a reading where

no uncertainty remains. We refer to Chapter 5 where this account building on ignorance is developed further.

8 Concluding remarks

The goals of this study were twofold. First, we investigated the relationship between children's interpretations of simple and negated disjunction (Research Question 1). Specifically, we hypothesized that children who compute scalar implicatures in simple disjunction also do so in negated contexts, arguing that enriched meanings in both contexts arise from the same underlying mechanisms, be they adult-like or not. Second, we investigated variation in interpreting negated disjunction in French, to see if there are two populations in French adults, and whether this variation is also attested in children (Research Question 2). Together, these questions aimed to shed light on the grammars underpinning the interpretations of disjunction and the variation between child and adult grammars. To carry out these goals, we designed an experiment which tested simple and negated disjunction within the same setup and participants. The setup included several methodological improvements over previous studies, in particular Singh et al. (2016), and Tieu et al. (2017). The design incorporated critical conditions to identify interpretive patterns for each disjunctive environment (*One Disjunct True* and *Two Disjuncts True* for simple disjunction; *No Disjunct True* and *One Disjunct True* for negated disjunction), as well as a sufficient amount of items to assess the robustness of individual patterns, especially for negated disjunction for which most previous studies did not report on individual patterns.

For simple disjunction, children gave non-adult-like *inclusive* and *conjunctive* readings, which we have accounted for by the absence of pragmatic reasoning or by a form of a non-adult-like reasoning. In particular, the *conjunctive* reading was explained by assuming that children know how to produce enriched meanings (via an exhaustification procedure), but fail to generate the *conjunctive* alternative, as originally proposed by Singh et al. (2016). Conversely, for the *inclusive* interpretation, we argued that children did not perform any form of pragmatic enrichment. By age 5, both non-adult-like interpretations tended to disappear in favor of the adult-like *exclusive* reading.

For negated disjunction, adults were divided between two populations with distinct interpretations. The largest group consistently gave an *exclusive* reading and the other group a *neither...nor* reading. This revealed that the *neither...nor* reading is a valid target interpretation for children in French, contrary to previous claims about French (Nicolae, 2017; Spector, 2014; Pagliarini et al., 2022) and corroborating Larralde et al.'s (2021) and Lungu et al.'s (2021) findings. In parallel, children were also divided between two groups. The majority of children gave a *neither...nor* reading which we argued could arise for three different reasons: (i) as a consequence of preferring to resolve as much ignorance as possible, (ii) from a genuine adult-like preference to interpret disjunction within the scope of negation, and (iii) via immature pragmatic reasoning that is structurally parallel to the reasoning leading to the conjunctive reading of simple disjunction. In particular the latter proposition was built on Singh et al.'s (2016) proposal that children face difficulty in generating alternatives that require scalar replacement. Finally, contrary to our predictions, the *not both* reading was not attested. We proposed that in the course of the acquisition of disjunction, the *not both* reading may not surface in the first place, and that it should be dispreferred if children truly dislike utterances carrying too much ignorance.

Finally, combining children's performance on both simple and negated disjunction revealed that a subset of the *neither...nor* interpreters were in fact adult-like. We also showed that

non-adult-like *conjunctive* and *inclusive* interpretations of simple disjunction were always paired with *neither...nor* readings in negated disjunction. We propose that each observed pattern can be explained by a distinct grammar, determined by the interplay of three factors: whether the *Exh* operator has been inserted in the structure and triggered pragmatic enrichment, the composition of the alternative set (complete or lacking the scalar alternative), and the scope of disjunction with respect to negation (above or below).

Chapter 4

Understanding negated disjunction: Prosodic disambiguation in adult French

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1 Introduction

Negated disjunctive statements such as (1) are reported to be principally ambiguous between an *exclusive* (1a) and a *neither...nor* (1b) interpretation, depending on the scopal configuration between disjunction and negation.

(1) Liz n'aime pas les mathématiques ou la géographie.
Liz AUX.3SG.PRS NEG DET maths or DET geography
Lit. "Liz does not like mathematics or geography."
a. Either Liz does not like mathematics or she does not like geography. *Exclusive*
b. Liz likes neither mathematics nor geography. *Neither...nor*

Finding cross-linguistic variation in the preferred interpretation of negated disjunction, Szabolcsi (2002) attributed the scopal ambiguity of (1) to a cross-linguistic parameter. In languages such as Japanese, Hungarian and Italian, disjunction is treated as a positive polarity item (PPI), forcing it to take scope above negation. This scope configuration allows for an exclusivity inference to arise, yielding the *exclusive* interpretation in (1a). In contrast, languages such as English, German and Korean allow disjunction to scope freely above or below negation. In the case where disjunction scopes below negation, a *neither...nor* interpretation is obtained by De Morgan's laws.

A critical assumption in the literature is that each language belongs to either one category or the other. However, recent empirical studies have challenged this strict typology. Cochard et al. (2023; see also Chapter 3) found two populations of speakers, concluding that different scopal preferences coexist in French. Lungu et al. (2021) demonstrated that, depending on the context, the alleged unavailable reading can surface as well in French, Italian, Romanian and English. Finally, Surányi and Gulás (2022) and van Hout et al. (2024) have provided evidence that prosody plays a key role in disambiguating the scope configuration of negated disjunction in Hungarian and Dutch, respectively. Against these novel findings, French presents an interesting test case. While Pagliarini et al. (2022) found that French adults derived the *exclusive* interpretation, the adults tested in Larralde et al. (2021) showed a strong preference for the *neither...nor* interpretation.

This discrepancy in adult French is particularly crucial for L1 French, which takes on adult performance as a reference point; thus, clarifying the adult grammar is a necessary step. Since French speakers appear to have access to both interpretations, we examined the role of prosody, a disambiguating factor that could help determining whether French disjunction can scope freely for all French speakers, or whether there are indeed two populations of speakers with rigid preferences that persist regardless of prosodic manipulations. To this end, we conducted two studies: Study 1 investigated whether French speakers associated each interpretation to distinct prosodic contours, while Study 2 further explored whether a specific prosodic contour could bias listeners toward one interpretation over the other.

Our findings revealed two key insights. First, prosody significantly influenced the interpretation of negated disjunction for some participants, confirming its disambiguating role. Second, other participants exhibited a stable preference for one interpretation over the other regardless of prosodic contour, corroborating Cochard et al.'s (2023) conclusion that there are two distinct speaker populations in French with different but rigid preferences. Overall, these findings suggest that the positive polarity status of French disjunction *ou* "or" should be reconsidered. We propose two concurrent explanations. First, Szabolcsi's (2002) cross-linguistic parameter may also be active at the individual level, with different speakers of a given language adopting a different setting of the parameter. Second, we suggest that the

different interpretations may also stem from syntax, potentially informed by prosodic cues, rather than from logical scope.

The chapter is structured as follows: Section 2 provides background on the interpretation of negated disjunction. Section 3 outlines the rationale for the two studies. Section 4 and Section 5 present Study 1 and Study 2, respectively. Section 6 offers a general discussion, and Section 7 concludes.

2 Negated disjunction

2.1 Cross-linguistic variation

Sentences like (2), containing two logical operators, namely, disjunction and negation, pose a challenge in interpretation for linguistic theory as they logically allow for more than one interpretation. Thus, logically speaking, (2), can receive the two interpretations in (3), depending on the underlying scope relationship between the two operators.

(2) Liz does not like mathematics or geography.

(3) a. **NEG > OR** $(\neg[P \vee Q])$
Liz likes neither mathematics nor geography. $(\neg P \wedge \neg Q)$
b. **OR > NEG** $(\neg P \vee \neg Q)$
Liz does not like mathematics or she does not like geography. $\neg(P \wedge Q)$

In (3a), disjunction scopes below negation $(\neg[P \vee Q])$, yielding the *neither...nor* reading $(\neg P \wedge \neg Q)$ as per De Morgan's laws illustrated in (4). Negating the disjunction of two propositions is equivalent to the conjunction of two negated propositions (4a), that is, both disjuncts must be false. In (3b), disjunction scopes above negation $(\neg P \vee \neg Q)$, yielding a *not both* reading $(\neg[P \wedge Q])$. The disjunction of two negated propositions is equivalent to the negation of a conjunction (4b), that is, at least one of the two disjuncts must be false.

(4) **De Morgan's laws:**
a. $\neg(P \vee Q) \Leftrightarrow (\neg P \wedge \neg Q)$ *Neither...nor*
b. $(\neg P \vee \neg Q) \Leftrightarrow \neg(P \wedge Q)$ *Not both*

In cases where the scope configuration yields a *not both* interpretation, an exclusivity inference can be additionally derived. The literal meaning in (5a) is strengthened by negating the scalar alternative with and in (5b), resulting in the exclusivity inference in (5c). Here, exactly one disjunct must be false. From this point forward, we will refer to this strengthened interpretation as the *exclusive* interpretation.

(5) Liz does not like mathematics or geography.
a. **OR > NEG scope configuration:**
Liz does not like mathematics or she does not like geography, possibly both.
b. **Scalar alternative:**
Liz does not like mathematics and she does not like geography.
c. **Exclusivity inference:**
$\rightsquigarrow$ Liz does not like mathematics or she does not like geography, but it is not the case she does not like both mathematics and geography.
$\Leftrightarrow$ Either Liz does not like mathematics or she does not like geography.

This ambiguity does not manifest uniformly across languages. A substantial body of

research has shown that access to the two readings of negated disjunctive statements varies cross-linguistically. Specifically, Szabolcsi (2002) identified two classes of languages with respect to which interpretation is accessible. In the first class, disjunction is interpreted outside of the scope of the (clausemate) negation, which yields an *exclusive* interpretation. Languages such as Japanese (Goro 2007; 6), Hungarian (Szabolcsi 2002; 7) and Italian (Pagliarini et al. 2022; 8) have been reported to fall into this category.

(6) John-wa supeingo-ka furansugo-o hanas-ana-i.
John-TOP spanish-or french-ACC speak-NEG-PRS
Lit. "John does not speak Spanish or French."
a. × John does speak neither Spanish nor French.
b. ✓ Either John does not speak Spanish or he does not speak French.

(7) Nem csukt-uk be az ajtò-t vagy az ablak-ot.
NEG close-1PL in DET door-ACC or DET window-ACC
Lit. "We did not close the door or the window."
a. × We closed neither the door nor the window.
b. ✓ Either we did not close the door or we did not close the window.

(8) Il gatto non ha mangiato la carota o il peperone.
DET cat NEG AUX eat.PART.PST DET carrot or DET pepper
Lit. "The cat did not eat the carrot or the pepper."
a. × The cat ate neither the carrot nor the pepper.
b. ✓ Either the cat did not eat the carrot or he did not eat the pepper.

In such languages, Szabolcsi (2002) claims that disjunction is a positive polarity item (PPI). Roughly, PPIs cannot appear in the immediate scope of a negation[1], except when the negated statement is itself embedded within a downward-entailing context. A typical case of PPI is English existential quantifier *some*, which cannot appear within the scope of negation (9), unless the latter is itself contained in a downward-entailing context[2] such as in the antecedent of a conditional statement, as in (10).

(9) Liz does not like some school options.
a. ✓ There are some school options that Liz does not like. $\exists > \neg$
b. × Liz does not like any school options. $\neg > \exists$

(10) If Liz does not do some chores, she will be punished.
a. × If there is at least one chore that Liz doesn't do, she will be punished. If($\exists > \neg$)
b. ✓ If Liz does not do any chore, she will be punished. If($\neg > \exists$)

Disjunction behaves similarly in languages where it has been argued to be a PPI. To illustrate, consider (11) for French, a language in which the disjunctive word *ou* "or" has been analysed as a PPI by Spector (2014) and Nicolae (2017). In (11), the negated disjunctive statement appears in the antecedent of a conditional and successfully yields the *neither...nor* interpretation.

[1] To be more precise, PPIs cannot appear in the immediate scope of an anti-additive operator, which generally includes, but is not limited to, sentential negation, *nobody*, *none*, *never*, *without*, etc. Anti-additivity is defined as follows: a function f is anti-additive if $f(P \vee Q) \Leftrightarrow f(P) \wedge f(Q)$.

[2] Downward-entailing contexts do not licence inferences from subsets to supersets. A function f is downward-entailing iff for every P, Q such that $P \subseteq Q$, $f(P) \Rightarrow f(Q)$.

(11) Si Liz ne fait pas ses devoirs de maths ou de géographie, elle sera punie.
"If Liz does not do her maths or geography assignments, she will be punished."
a. ✕ If($\vee > \neg$):
If there is at least one assignment that Liz doesn't do, she will be punished.
b. ✓ If($\neg > \vee$):
If Liz does neither assignment, she will be punished.

For the second class of languages, negated disjunctive statements are often described as ambiguous between a *neither...nor* and an *exclusive* interpretation. Languages such as English, Dutch (Pagliarini et al. 2022; (12)), German (Geçkin et al. 2018; (13)), and Korean (Lee 2010; (14)) are typically classified in this group. Note that, however, most experimental data indicate that native speakers of these languages strongly favor the *neither...nor* reading.

(12) De poes houdt niet van wortel of paprika.
DET cat AUX NEG like carrot or pepper
Lit. "The cat does not like carrots or peppers."
a. ✓ The cat likes neither carrots nor peppers.
b. ✓ Either the cat does not like carrots or he does not like peppers.

(13) Dieses Tier hat nicht die Karotte oder die Paprika gegessen.
DET animal AUX NEG DET carrot or DET pepper eat.PST
Lit. "This animal did not eat the carrot or the pepper."
a. ✓ This animal ate neither the carrot nor the pepper.
b. ✓ This animal did not eat the carrot or it did not eat the pepper.

(14) Mary-nun sakwa-na pay-lul an mek-nun-ta.
Mary-NOM apple-or pear-ACC NEG eat-PRS-DECL
Lit. "Mary did not eat apples or pears."
a. ✓ Mary ate neither apples nor pears.
b. ✓ Either Mary did not eat apples or she did not eat pears.

Cross-linguistic variation in the interpretation of negated disjunction has been the focus of considerable attention in the literature. Table 1, repeated from Chapter 3, presents a non-exhaustive list of languages classified into two categories depending on the alleged preferred interpretation.[3]

The PPI parameter for disjunction also played a central role in numerous acquisition studies which have shown that children aged 4 to 5 systematically favor the *neither...nor* interpretation, regardless of the preferred adult interpretation in the language they are acquiring. To account for this robust preference, Goro and Akiba (2004), along with most subsequent research, proposed that children adhere to a developmental principle known as the Semantic Subset Principle, introduced by Crain et al. (1994) (see also Crain & Thornton, 1998; Crain, 2012). When applied to negated disjunction, this principle predicts that children default to the scope configuration that yields the interpretation that is true in the narrowest range of circumstances, namely, the *neither...nor* reading. For a more in-depth discussion of the acquisition of negated disjunctive statements and the mechanisms underpinning this developmental principle, see Chapter 3.

[3] Several studies cited here tell in fact a more nuanced story. For instance, in French, Cochard et al. (2023), Larralde et al. (2021) and Lungu et al. (2021), without denying the preference for the *exclusive* interpretation, show that the *neither...nor* interpretation is accessible and even preferred for some speakers.

Preference for *Exclusive* (OR > NEG + Implicature)	Preference for *Neither...nor* (NEG > OR)
Catalan (Pagliarini et al., 2021) **French** (Cochard et al., 2023; Lungu et al., 2021; Pagliarini et al., 2022) **Hungarian** (Szabolcsi, 2002; Surányi & Gulás, 2022) **Italian** (Pagliarini et al., 2018b, 2022) **Japanese** (Goro & Akiba, 2004; Goro, 2007) **Mandarin Chinese** (Jing, 2008) **Russian** (Verbuk, 2006) **Turkish** (Geçkin et al., 2018)	**Bulgarian** (Szabolcsi, 2002) **Dutch** (Pagliarini et al., 2022; van Hout et al., 2024) **English** (Larson, 1985; Chierchia et al., 2004; Lungu et al., 2021) **German** (Geçkin et al., 2018) **Greek** (Szabolcsi, 2002; Tsakali, 2021) **Korean** (Lee, 2010; O'Grady et al., 2011; Lee & Schwartz, 2024) **Romanian** (Lungu et al., 2021; Szabolcsi, 2002) **Spanish** (Lobina et al., 2023b; Becerra Zita et al., 2014) **Warlpiri** (Bowler, 2014)

Table 1: Classification of languages with respect to the alleged preferred interpretation.

Summarising, the distribution of the interpretations of negated disjunction appears to be neatly organised cross-linguistically, dividing languages into two clear categories. In languages where disjunction is analysed as a PPI (+PPI languages), only the *exclusive* interpretation is supposedly available, while in languages where it is not (–PPI languages), both the *exclusive* and the *neither...nor* can be derived, although the latter appear to be far more frequent. Yet, as will be discussed below, this ideal division has been contested in the literature. Several authors reported different intuitions, supplying empirical data revealing availability of the alleged unavailable interpretation, be it the *neither...nor* reading in +PPI languages (Section 2.2), or the *exclusive* reading in –PPI languages (Section 2.3).

2.2 Is the *neither...nor* reading available in +PPI languages?

A recurring debate in the literature concerns the question whether the *neither...nor* interpretation is possibly accessible in +PPI languages. Take French, for instance, which has been consistently classified as a +PPI language (Spector, 2014; Nicolae, 2017; Pagliarini et al., 2022). However, as we will show below, this conclusion cannot be right, as it both overlooks experimental findings and corpus data. First, a corpus search in the Frantext database[4] revealed that negated disjunctive statements conveying a *neither...nor* interpretation are well attested in French literature, from the Middle Ages to the present day[5], as shown in examples (15) through (18).

(15) a. D'avantage que l'appetit de vengeance s'en assouvit et contente mieux, car elle ne vise qu'à donner ressentiment de soy. **Voilà pourquoy nous n'attaquons pas une beste ou une pierre quand elle nous blesse**, d'autant qu'elles sont incapables de sentir nostre revenche. Et de tuer un homme, c'est le mettre à l'abry de nostre offence.
(Michel de Montaigne, *Essais*, book 1, 1592, p.165)

b. "That is why we do not attack a beast or a stone when it harms us."

[4] www.frantext.fr

[5] We found more than 800 occurrences of negated disjunctive statements in texts ranging from year 1220 to 2023, though we did not conduct a thorough classification of each of these occurrences.

(16) a. Ménage-la, et ne la fais pas souffrir. **Le coeur d'une femme est une chose si délicate quand ce n'est pas un glaçon ou une pierre** ! Je crois qu'il n'y a guère de milieu et il n'y en a pas non plus dans ta manière d'aimer et d'estimer.
(George Sand, *Correspondance : 1834*, p.588)
b. "A woman's heart is such a delicate thing, when it is not an ice cube or a stone!"

(17) a. [...] mais j'aurais pu lui rendre la pareille, **je ne saisissais pas l'esprit ou la sottise**, l'éloquence ou l'enflure qu'il trouvait dans une réplique ou dans un discours, et l'absence de toute raison perceptible pour quoi ceci était mal et ceci bien [...]
(Marcel Proust, *A la recherche du temps perdu*, book 2, 1918, p.459)
b. "I did not grasp the spirit or the folly."

(18) a. Il nous semble pourtant que Boas effleurait là une importante vérité. Pour la reconnaître, il aurait suffi que, contrairement à une position souvent affirmée, **Boas ne réduisît pas le conte ou le mythe à un simple récit**, et qu'il acceptât de rechercher, derrière le discours mythique, le schème fait d'oppositions discontinues qui préside à son organisation.
(Claude Lévi-Strauss, *La Pensée Sauvage*, 1962, p.165)
b. "Boas did not reduce the tale or myth to a mere story."

Moreover, the *neither...nor* interpretation is not limited to French literature. A corpus search on the French internet, using the frTenTen23 corpus (Jakubíček et al., 2013; Suchomel, 2020; Suchomel & Pomikálek, 2012) revealed that the *neither...nor* interpretation also arises in a wide range of non-literature environments, including encyclopedic context (19), press articles (20) and even in the official national health insurance website (21).

(19) a. Et dans ce domaine, il n'existe pas de règle ou de formule de dimensionnement [...]
(Wikipedia.fr, 2025; "Coagulation-floculation")[6]
b. "And in this field, there is no rule or dimensioning formula [...]"

(20) a. Lorsque l'on fait du porte-à-porte, les Nantais ne parlent pas du bruit ou des problèmes de sécurité des avions, mais de leur quotidien.
(Le Monde.fr, 2014; "A Nantes, écolos et socialistes évitent les sujets qui fâchent")[7]
b. "When we go door-to-door, the people of Nantes do not talk about noise or safety issues on planes, but about their daily life."

(21) a. Si vous pensez que votre enfant a la varicelle (ou si celle-ci est suspectée), ne lui donnez pas d'ibuprofène ou de kétoprofène car les anti-inflammatoires non stéroïdiens augmentent le risque de complications infectieuses bactériennes de la varicelle.
(Ameli.fr; Varicelle : que faire et quand consulter ?)[8]
b. "If you think your child has (or is suspected to have) chickenpox, do not give your child ibuprofen or ketoprofen as NSAIDs increase the risk of bacterial infectious complications from chickenpox."

[6] https://web.archive.org/web/20250628214532/https://fr.wikipedia.org/wiki/Coagulation-floculation
[7] https://web.archive.org/web/20221127112339/https://www.lemonde.fr/politique/article/2014/02/22/a-nantes-ecolos-et-socialistes-evitent-les-sujets-qui-fachent_4371524_823448.html
[8] https://web.archive.org/web/20250515165839/https://www.ameli.fr/assure/sante/themes/varicelle/que-faire-cas-faut-consulter

In addition to corpus data, experimental findings from Becerra Zita et al. (2014), Cochard et al. (2023; see also Chapter 3), Larralde et al. (2021) and Lungu et al. (2021) further support that the *neither...nor* reading is genuinely a possible interpretation of French negated disjunctive statements. In a truth-value judgement task investigating whether children were sensitive to prosody in negated disjunctive statements, Larralde et al. (2021) found, in pilot testing adults, that they systematically accessed the *neither...nor* reading when the disjunctive word *ou* "or" did not bear any prosodic stress. In an acceptability judgement task using a 1-to-7 scale testing disambiguated continuations of a negated disjunctive statement, Lungu et al. (2021) found that their participants rated continuations that enforced the *neither...nor* interpretation as high as continuations enforcing the *exclusive* one. Finally, in a truth-value judgement task investigating how the interpretation of disjunction is consistent across different linguistic environments, Cochard et al. (2023) (see also Chapter 3) found two adult populations with different preferences: some participants consistently showed the *exclusive* interpretation while others showed the *neither...nor* interpretation.

2.3 The *exclusive* reading in –PPI languages appears under specific conditions

Although disjunction is free to scope above or below negation in –PPI languages, allowing both the *exclusive* and the *neither...nor* interpretation, this ambiguity is not consistently reflected in experimental data. Most empirical data available for –PPI languages point towards the same conclusion: speakers of these languages strongly favour the *neither...nor* interpretation. For instance, in a truth-value judgement task, Pagliarini et al. (2022) found that adult Dutch speakers consistently rejected a condition where only one disjunct was true (8% of acceptance rate), while accepting a condition where no disjunct was true (94% of acceptance rate): these participants systematically manifested a *neither...nor* reading. Similar results were found for English (Chierchia et al., 2004), German (Geçkin et al., 2018) and Korean (Lee, 2010; Lee & Schwartz, 2024; O'Grady et al., 2011). Moreover, Lungu et al. (2021) found that English speakers rated continuations enforcing the *exclusive* interpretation significantly lower (4.07 out 7) than those enforcing the *neither...nor* reading (6.41 out of 7). But, importantly, the *exclusive* interpretation was not completely rejected. Lungu and colleagues argued that the apparent unavailability of the *exclusive* interpretation in binary truth-value judgement tasks (yes-no true-false, etc.) does not mean that this interpretation is never accessible. Rather, Lungu and colleagues show that when considering different types of tasks, such as the acceptability judgement task they used in their protocol, an alleged unavailable reading may surface.

In parallel, several studies have shown that the *exclusive* interpretation can be primed, either contextually, as shown below, or by prosody as detailed in Section 2.4. For example, consider (22) taken from van Hout et al. (2024). With the context in (22a), the authors argue that Dutch speakers hearing (22b) allow for an *exclusive* interpretation (22b-ii).

(22) a. **Context:** John is holding up an adaptor and seems to be looking for his device.
b. Blijkbaar kan hij zijn telefoon of laptop niet vinden.
apparently can 3SG.M POSS phone or laptop NEG find-INF
Lit. "Apparently he cannot find his cell phone or laptop."
(i) ?? John found neither his cell phone nor his laptop.
(ii) ✓ Either John cannot find his cell phone or he cannot find his laptop.

Moreover, negated disjunctive statements can be disambiguated in –PPI languages by manipulating the Question Under Discussion, either explicitly, e.g. at the level of the

conversation (Verbuk, 2006), or implicitly, e.g. by manipulating contextual information (Jing, 2008). Take example (23) from Verbuk (2006), illustrating a conversation between two speakers. One speaker utters the sentence in (23a), asking which language Mary does not speak. A second speaker then utters the negated disjunctive statement in (23b). With the disambiguation introduced earlier in the conversation, taking the form of (23a), (23b) yields an *exclusive* interpretation.

(23) a. I know that Mary does not speak one of the languages that were in the job description. Do you remember what language she doesn't speak?
b. Mary does not speak Russian or German.
(i) × Mary speaks neither Russian nor German.
(ii) ✓ Either Mary does not speak Russian or she does not speak German.

Jing (2008) further noticed that English adults seemed to have different preferences in interpreting negated disjunction. In her acquisition studies, Jing (2008) designed two conditions, a positive and a negative goal, to manipulate the Question under Discussion and prime one or the other interpretation. In the positive goal condition, the story revolved around success in finishing tasks such as fixing objects or watering plants. In the negative goal condition, the characters of the story were rewarded if they successfully avoided negative outcomes such as hitting obstacles or dropping objects. While the positive goal condition was designed to allow ambiguity in the interpretation of negated disjunction, the negative goal condition was designed to favour the *neither...nor* one. In the negative goal condition Jing (2008) found that Mandarin Chinese adults were split into two groups: one group consistently rejected the test sentence while the other consistently accepted it. In a similar manner as for French, it appeared that Mandarin Chinese also featured two adult populations with distinct preferences.

2.4 Prosody as a disambiguating factor

This section delves further into another disambiguating factor that is central to this chapter, namely, prosody. The effect of prosody in the disambiguation of interacting logical operators has been widely investigated, with numerous studies providing evidence that prosody affects listeners' interpretation. For instance, developing work from Bolinger (1965), Jackendoff (1972) discussed the effect of prosody to disambiguate the scope interaction between universal quantifiers and negation. Consider example (24) which logically allows for the two interpretations in (24a) and (24b).

(24) **All** the men did**n't** go.
a. None of the men went. $\forall > \neg$
b. Some (but not all) men went. $\neg > \forall$

Jackendoff (1972) proposed that the two interpretations in (24) can be disambiguated by prosody. Specifically, Jackendoff (1972) claims that the interpretation in (24a) (where the universal quantifier takes scope over negation) is marked by a sentence-final falling contour, illustrated in (25), whereas the interpretation in (24b) (where negation takes scope over the universal quantifier) is marked by a fall-rise contour, illustrated in (26).

(25) $\forall > \neg$ **scope configuration:**

a. ALL the men didn't go.

b. $\rightsquigarrow$ None of them went.

(26) $\neg > \forall$ **scope configuration:**

a. ALL the men didn't go.

b. $\rightsquigarrow$ Some (but not all) men went.

Jackendoff's intuitions inspired numerous studies which showed that prosody influences sentence interpretation across a wide range of lexical items (e.g. Kadmon & Roberts, 1986; Ladd, 1980; Ward & Hirschberg, 1985; Fodor, 2002). The specific prosodic effects outlined in (25) and (25) were experimentally confirmed by Syrett et al. (2014), but until Larralde et al. (2021) no study had directly investigated how prosody affects the scope of disjunction relative to negation. Since then, two further studies have addressed this issue: Surányi and Gulás (2022) and van Hout et al. (2024), both reviewed below. Prior to these, Szabolcsi (2002) had noted that, in English, stressing disjunction in a negative sentence disambiguates toward the *neither...nor* interpretation. More precisely, she argued that while unstressed negated disjunction is ambiguous between the two readings in (27), stressed negated disjunction is not (28).

(27) John hasn't taken Chemistry 1 or Physics 10. (Szabolcsi, 2002; p.19)

a. ✓ John took neither Chemistry 1 nor Physics 10. NEG > OR

b. ✓ Either John hasn't taken Chemistry 1 or he hasn't taken Physics 10. OR > NEG

(28) John hasn't taken Chemistry 1 OR Physics 10. (Szabolcsi, 2002; p.19)

a. ✓ John took neither Chemistry 1 nor Physics 10. NEG > OR

b. × Either John hasn't taken Chemistry 1 or he hasn't taken Physics 10. OR > NEG

Larralde et al. (2021) investigated whether French-speaking children were sensitive to prosodic cues when stress is positioned on the disjunctive word *ou* "or." To this end, they designed a truth-value judgement task in which different puppets described the outcome of a story using a negated disjunctive statement, such as the utterance in (29). Each test sentence was presented in three conditions, depending on how many disjuncts were true (either one, two, or none). Participants were divided into two groups: one group heard the negated disjunctive statement with neutral prosody (see Figure 1), while the other group heard the same sentence with stress inserted on the disjunctive connective (see Figure 2).

(29) Le dinosaure n'a pas mangé la pomme ou l'orange.
The dinosaur NEG.AUX.PRS.3SG NEG eat.PART.PST the apple or the.orange
The dinosaur did not eat the apple or the orange.

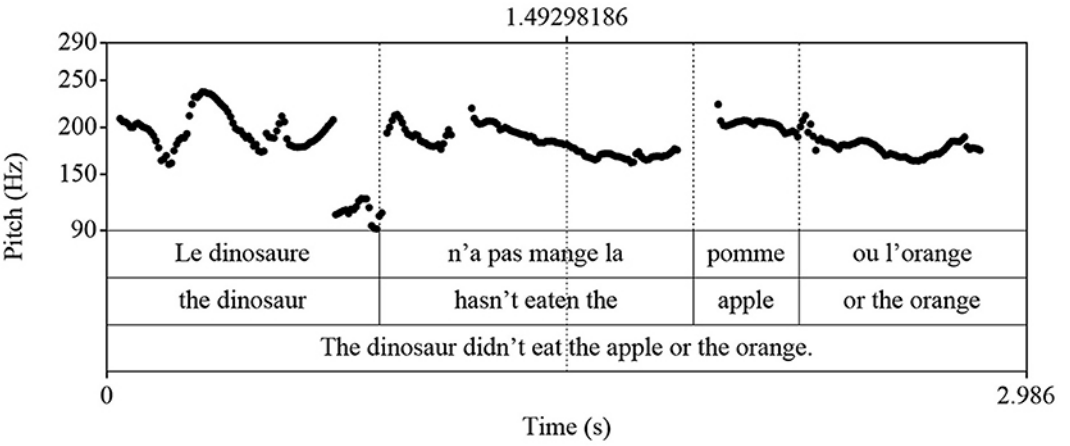


Figure 1: Pitch track of the sentence in (29) with neutral intonation in Larralde et al. (2021).

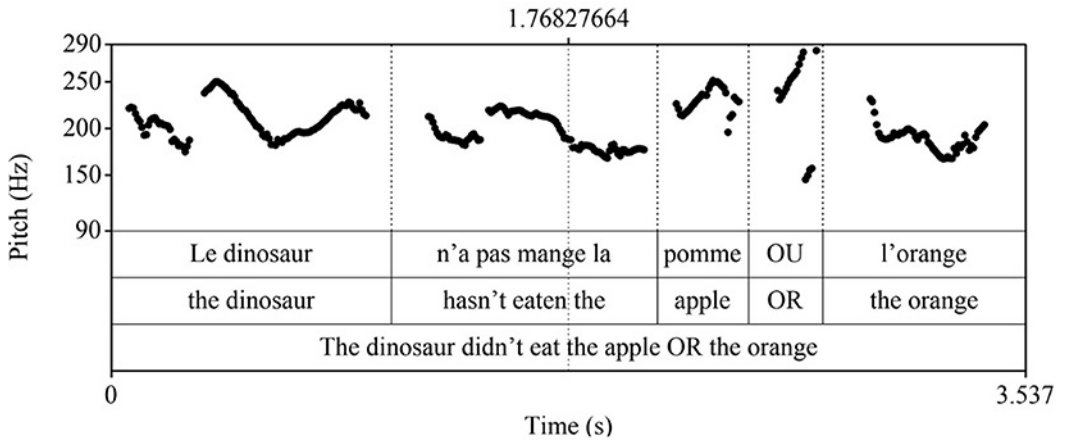


Figure 2: Pitch track of the sentence in (29) with stress on disjunction in Larralde et al. (2021).

Children who heard the neutral prosody condition showed a clear *neither...nor* interpretation, consistently accepting the scenario where no disjunct was true (96%) and rejecting the scenario where only one disjunct was true (7%). In contrast, in the stressed prosody condition, children exhibited a more nuanced pattern: while they also largely accepted the condition in which no disjunct was true (85%), they were significantly more likely to accept the condition where only one disjunct was true (37%). Although these findings suggest that prosody influenced French children's interpretation of negated disjunction, they cannot be straightforwardly generalised to French adults. Larralde and colleagues did include an adult control group, but they only reported these data as a baseline and did not investigate whether prosody had a significant effect on adults.

To the contrary, Surányi and Gulás (2022) tested adults, hypothesising that distinct prosodic contours would lead to different interpretations in Hungarian, a +PPI language according to Szabolcsi (2002). Using a picture-verification task adapting Goro and Akiba's (2004) methodology, Surányi and Gulás prompted participants to evaluate a negated disjunctive description, such as (30), that was presented orally in one of two prosodic variants. The first variant, intended to prime the *exclusive* interpretation, featured a pitch rise on the first disjunct, followed by a pause and a pitch fall on the second disjunct (Figure 3). The second variant, intended to prime the *neither...nor* interpretation, involved a pitch rise on negation followed by a neutral pitch on the rest of the sentence (Figure 4).

(30) A malac nem ette meg a répát vagy a paprikát.
the pig NEG eat.PST.3SG PV the carrot.ACC or the pepper.ACC
"The pig didn't eat the carrot or the pepper."

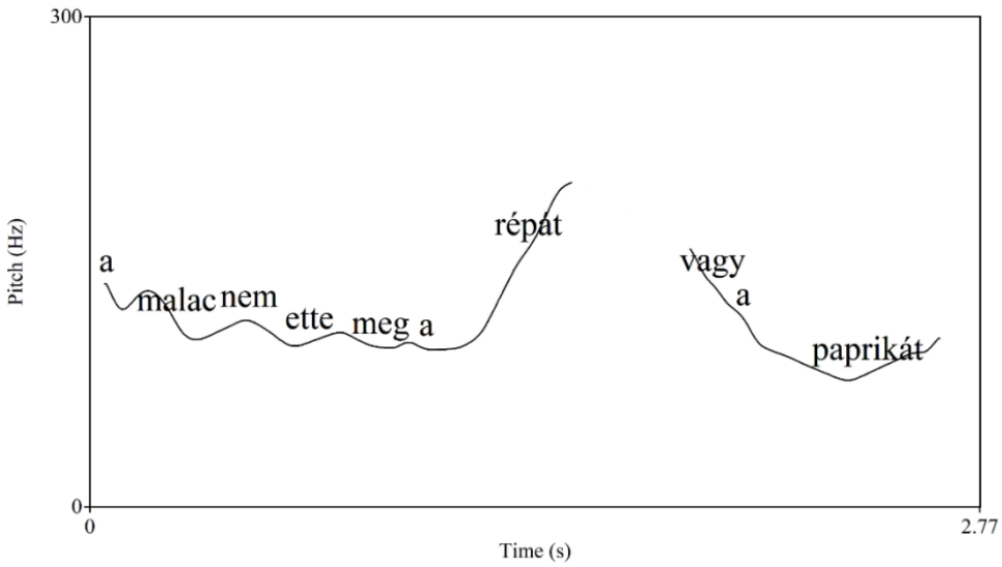


Figure 3: Pitch track of the prosodic contour marked for the *neither...nor* interpretation in Surányi and Gulás (2022).

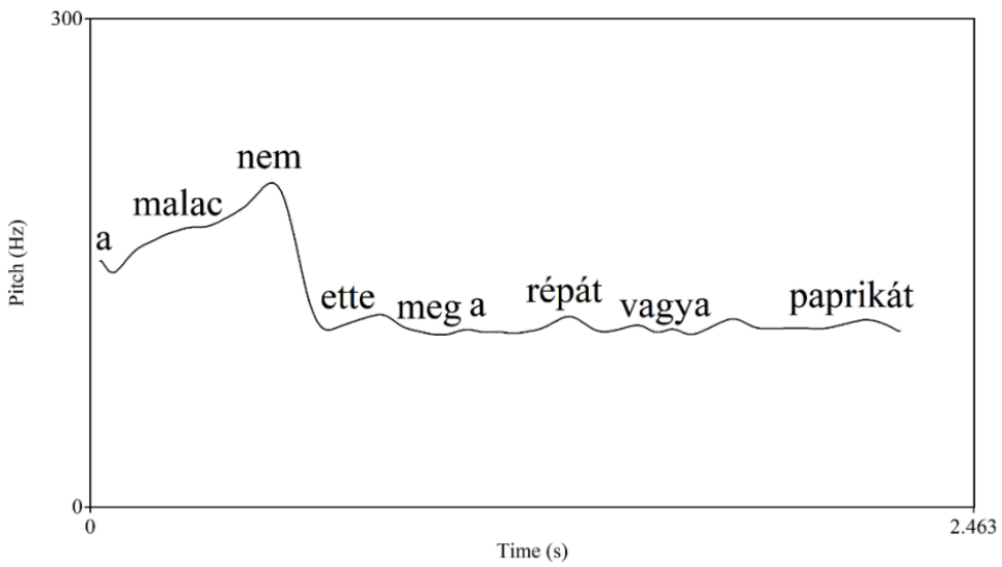


Figure 4: Pitch track of the prosodic contour marked for the *exclusive* interpretation in Surányi and Gulás (2022).

Overall, while the Hungarian adults exhibited a clear preference for the *exclusive* interpretation, the results revealed that prosody significantly influenced the participants' responses. Specifically, participants were more likely to accept scenarios where no disjunct was true when presented with the prosodic contour that was meant to prime the *neither...nor* interpretation (Figure 3) than with the other one that was meant to prime the *exclusive* interpretation (Figure 4). Conversely, acceptance rates for scenarios where one disjunct was true were higher when the prosodic contour was marked for the *exclusive* interpretation than when it was marked for the *neither...nor* interpretation. Surányi and Gulás (2022) concluded that, even

though most Hungarian adults conformed to the interpretation in line with +PPI nature of the connective *vagy*, prosody nevertheless played a role in the accessibility of the otherwise allegedly unavailable *neither...nor* interpretation.

Contrary to Szabolcsi's (2002) claim that stressing disjunction disambiguates negated disjunctive statements toward a *neither...nor* interpretation in English, van Wijk et al. (2019) proposed the opposite for Dutch. According to van Wijk and colleagues, a neutral prosodic contour with no specific stress favours the *neither...nor* interpretation, whereas a contour with stress on disjunction favours the *exclusive* interpretation. Building on this hypothesis, van Hout et al. (2024) designed a forced-choice prosody task in which Dutch speakers matched a given interpretation to one of two prosodic contours. Participants first read a short story that disambiguated either the *exclusive* (31) or the *neither...nor* interpretation (32). Then, they listened to two prosodic variants of the same negated disjunctive statement, such as (32), presented sequentially, and were asked to select one. Prosody was manipulated using the same contours as in Surányi and Gulás (2022).

(31) **Disambiguated *exclusive* story:** (van Hout et al., 2024; p.31)

a. Ik heb vorige week een afspraak met Marie gemaakt maar ik heb het niet meteen in mijn agenda geschreven. Nu weet ik niet meer precies op welke dag we uitgekomen waren. Ik kon dinsdag en donderdag, maar Marie kon niet op één van die dagen. Ik weet alleen niet meer welke.

b. "I made an appointment with Marie last week, but I didn't immediately write it in my calendar. Now I don't remember exactly which day we selected. I could do Tuesday and Thursday, but Marie couldn't do one of those days. I just don't remember which one."

(32) **Disambiguated *neither...nor* story:** (van Hout et al., 2024; p.31)

a. Ik wilde vorige week al een afspraak met Marie maken, maar ik heb haar niet meteen gebeld. Ondertussen kan ik nog maar op dinsdag en donderdag. Maar toen ik haar net belde bleek dat het niet meer gaat lukken deze week.

b. "I wanted to make an appointment with Marie last week, but I didn't call her right away. In the meantime I can only do Tuesdays and Thursdays. But when I just called her, it turned out that it will not work out anymore this week."

(33) Marie kon niet op dinsdag of op donderdag.
Marie can.3SG.PST NEG on Tuesday or on Thursday
"Marie could not make it on Tuesday or Thursday."

Van Hout and colleagues obtained clear results: participants consistently selected the *neither...nor* marked prosodic contour in *neither...nor* stories (85%), and the *exclusive* marked prosodic contour in *exclusive* stories (70%). These findings support the view that the Dutch disjunctive word *of* is not a positive polarity item and can therefore scope freely above or below negation. Taken together, the results of Larralde et al. (2021) for French children, Surányi and Gulás (2022) for Hungarian adults, and van Hout et al. (2024) for Dutch adults converge on the idea that prosody plays a central role in shaping the interpretation of negated disjunction across typologically different languages (i.e. + and –PPI languages). What remains unclear, however, is whether this generalisation extends to French adults and, crucially, how French should be classified with respect to the +PPI/–PPI parameter. Crucially, the two experiments below examine French adults in order to determine not only whether prosody drives interpretation, but also whether French patterns with +PPI or –PPI languages.

3 Present study

Classifying languages into two categories based on the preferred interpretation of negated disjunctive statements, Szabolcsi (2002) attributed this cross-linguistic variation to a positive polarity parameter. In one category (including languages such as English, Dutch, and Korean), disjunction is interpreted under the scope of negation, yielding a *neither...nor* reading as per De Morgan's laws. In the other category, disjunction functions as a positive polarity item (PPI) and is therefore interpreted above negation, leading to an *exclusive* interpretation. Languages such as Japanese, Italian, and Hungarian have been reported to belong to this group. However, several studies have challenged this binary classification, demonstrating that the alternative reading remains accessible, either through contextual manipulation (Jing, 2008; Verbuk, 2006) or via prosodic cues (van Hout et al., 2024; Surányi & Gulás, 2022; van Wijk et al., 2019). In this regard, several recent studies using various experimental approaches present French as an interesting test case. Against Nicolae's (2017) and Spector's (2014) claim that French disjunction *ou* is a PPI and therefore allows for the *exclusive* reading to be derived, (Larralde et al., 2021) reported acceptance of the alleged unavailable interpretation: the adults consulted for their pretest systematically assigned a *neither...nor* interpretation to negated disjunction and did not access the *exclusive* interpretation. In contrast, in an acceptability judgement task, Lungu et al. (2021) found that, while French speakers graded negated disjunction disambiguated toward the *exclusive* interpretation high, in line with findings from French adults in Pagliarini et al. (2022), they also accepted such statements when it was disambiguated toward the *neither...nor* interpretation. Moreover, Cochard et al. (2023), and Chapter 3, found two populations of speakers with different preferences in French. The larger group consistently accepted the *exclusive* interpretation, while the smaller one accepted the *neither...nor* interpretation. In sum, French does not behave following the implications of its alleged +PPI status.

This study investigates negated disjunctive statements in French, asking whether French disjunction *ou* ("or") is truly a positive polarity item. To address this question, we examine whether distinct prosodic contours systematically correspond to the *exclusive* and *neither...nor* interpretations (34a), thus serving as reliable disambiguating cues; and whether French listeners use these prosodic contours to access both interpretations, or consistently favour a single interpretation regardless of prosodic variation (34b). If distinct prosodic cues reliably guide interpretation and both readings are accessed, this would challenge the status of *ou* as a positive polarity item. Conversely, if listeners consistently favour the *exclusive* interpretation regardless of prosody, it would support the view that *ou* behaves instead as a positive polarity item.

(34) Research questions:
   a. Is French disjunction *ou* "or" truly a positive polarity item?
   b. Do French speakers systematically associate distinct prosodic contours with the *exclusive* and the *neither...nor* interpretations in French, or do they tend to favour a single interpretation regardless of prosody?

Building on earlier studies (van Hout et al., 2024; van Wijk et al., 2019; Surányi & Gulás, 2022), we adopted two experimental approaches. In Study 1, we investigated whether participants, when given a choice, would systematically associate a specific interpretation to a particular prosodic contour. To this end, we adapted Van Hout et al.'s design to French: using a prosody selection task, negated disjunction was tested with two different prosodic contours, similar to those used by Surányi and Gulás (2022) for Hungarian. We measured the extent to which each prosodic contour was selected after a disambiguating story enforcing

either an *exclusive* or a *neither...nor* interpretation, roughly similar to the way Lungu et al. (2021) used disambiguating continuations to probe whether both interpretations were available in English, French, Italian and Romanian. Study 2 employed a truth-value judgement task to further investigate whether a particular prosodic contour actively biases listeners toward preferring one interpretation over the other.

Framed within a long line of research on the prosody-semantics interface (Bolinger, 1965; Jackendoff, 1972; Syrett et al., 2014; Kadmon & Roberts, 1986; Ladd, 1980; Ward & Hirschberg, 1985; Pruitt & Roelofsen, 2013; Larralde et al., 2021; Surányi & Gulás, 2022; van Hout et al., 2024; among many others) this study addresses the hypothesis that prosody plays a crucial role in resolving scope ambiguities, extending this hypothesis to a novel domain: the effect of prosody on negated disjunction. Empirically, this study contributes to semantic theory concerning cross-linguistic scope differences by testing whether both the *exclusive* and *neither...nor* readings are accessible in French, an alleged +PPI language. Crucially, Szabolcsi's (2002) positive polarity parameter predicts that in a +PPI language, *neither...nor* readings should never be attested. Accessibility of both readings in French would thus challenge the PPI status of *ou*, and further call into question the robustness of Szabolcsi's cross-linguistic parameter.

Although both studies focus on adult French speakers, the findings have consequences for the acquisition literature too. If French speakers are shown to allow *neither...nor* readings, this would challenge a long-standing body of acquisition studies that treats the *neither...nor* reading as non-adult-like in +PPI languages (Goro & Akiba, 2004; Goro, 2007; Pagliarini et al., 2022; Chierchia et al., 2004; Cochard et al., 2023; Geçkin et al., 2018; Lee, 2010). In particular, evidence that adults can access the allegedly unavailable *neither...nor* interpretation in an alleged +PPI language would call for a more nuanced interpretation of previous acquisition results and closer examination of adult data.

4 Study 1: Mapping interpretations to prosodic contours

Study 1 seeks to investigate to what extent a given interpretation is associated with a specific prosodic contour of a negated disjunctive statement. To this end, participants read short stories elaborated to disambiguate towards either an *exclusive* or a *neither...nor* interpretation of a target sentence, and then select their preferred prosodic contour. If the interpretation of negated disjunctive statements is paired with specific prosodic contours, participants should prefer one contour in stories disambiguated towards the *exclusive* reading, and another in stories disambiguated towards the *neither...nor* reading. Conversely, if the tested prosodic contours are not associated with specific interpretations, participants' responses should be inconsistent, or some participants may consistently prefer one prosodic contour regardless of story type.

We designed a forced-choice selection task, presented in Section 4.1, adapting van Hout et al.'s (2024) design to French. Section 4.2 reports the results, and Section 4.3 summarises the findings.

4.1 Method

4.1.1 Participants

A total of 40 native French-speaking adults (range = 19-62, M = 33) participated in the experiment. To be included in the study, participants had to be native French speakers from France with no self-declared cognitive, visual or hearing impairments. Participants were

recruited using Prolific.[9] Adults were paid £2.25 for a 15 minutes advertised experiment, complying with the recommended hourly rates set by Prolific.

4.1.2 Procedure

Study 1 featured a binary forced-choice task. Participants were instructed to carefully read a short story on the screen, as in Figure 5 (translation given in (35) below). Reading time was not limited. After reading, participants pressed the space bar of their keyboard to proceed to the next step. At this point, the story was removed and two circles appeared on each side of the screen, as illustrated in Figure 6. Two recordings of the same sentence were played in turn, each featuring a different prosodic contour. As the first recording was playing, the left circle temporarily enlarged and lit up; the same happened for the right circle when the second recording was playing. Each circle contained a different letter: "F" for the left circle and "J" for the right circle, to indicate which key to press on the next screen. Once both recordings finished playing, the final screen showed up automatically, as in Figure 7. The two circles remained visible in their neutral state and participants were prompted to select their preferred pronunciation by pressing the corresponding key on their keyboard.[10] They had been instructed at the outset to choose as fast as possible.

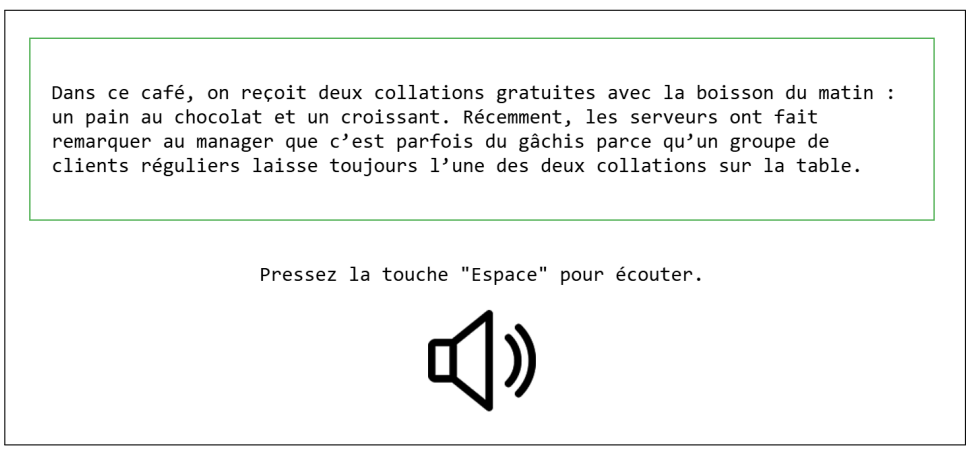
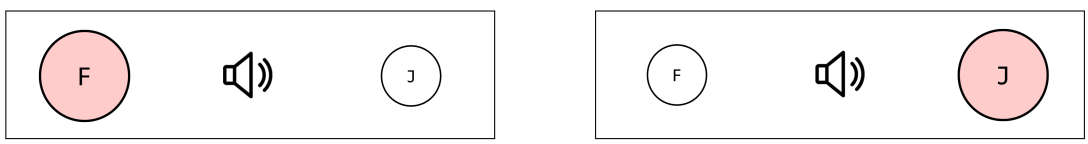


Figure 5: First phase of a trial: Reading a short story.

(35) **Translation of Figure 5**

a. "At this cafe, you receive two free snacks with your coffee in the morning: a chocolate bread and a croissant. Recently, the staff told management that they think this can be wasteful, since a group of regular customers always leaves one of the pastries on their plates."

b. "Press the space bar to listen."



(a) First audio being played **(b)** Second audio being played

Figure 6: Second phase of a trial: Listening to two recordings.

[9] https://www.prolific.com

[10] In their study, van Hout et al. (2024) prompted participants to click on a number corresponding to the prosodic contour they preferred. As our study also recorded reaction times, keyboard strokes were preferred, as they are generally faster and more precise than mouse clicks.

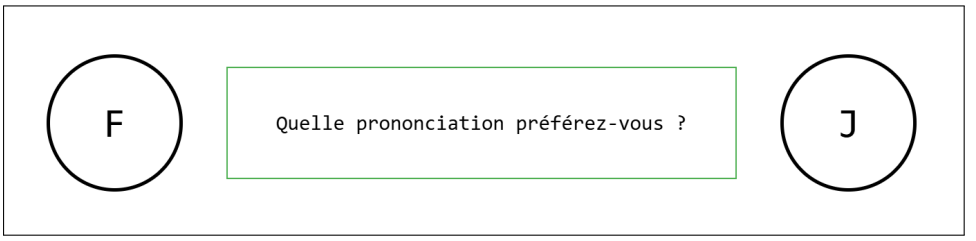


Figure 7: Third phase of a trial: Selecting "F" or "J" to indicate the preferred prosody. Text says: "Which pronunciation do you prefer?"

The "F" and "J" keys always corresponded to the left and right circles, respectively, as they appear on most keyboard layouts. Reaction times were recorded from the offset of the last audio to the moment participants pressed "F" or "J". Participants could not replay the recordings. They were instructed to follow their intuition when making their selection. Before the experiment, participants completed a short questionnaire regarding their age, dominant hand, and whether they had any native languages besides French.

The experiment was conducted online, using OpenSesame to write and compile the script (Mathôt et al., 2012; Mathôt & March, 2022) and a private JATOS server (Lange et al., 2015) to host the experiment and the data.

4.1.3 Stimuli and conditions

The design incorporated two critical conditions which varied the type of story to either target the *neither...nor* or the *exclusive* interpretation of a negated disjunctive statement. The design was within-subjects and participants saw six items of each condition (i.e. 12 critical items in total). Indeed, having six items was necessary to detect whether participants were consistent in their individual answers.

For each test sentence, pairs of stories were created. Each story minimally differed from the other by introducing disambiguating elements, so that they strongly favoured one interpretation over the other. For instance, for the test sentence in (36), which logically allows for the interpretation in (36a) and (36b), we created the stories in (37) and (38). In (37), the story explicitly states that one of the two disjuncts is never picked by the regular customers, while it is implied that they kept the other. Here, one disjunct is false while the other is true, which matches the *exclusive* interpretation of (36). Conversely, in (38), by mentioning that a third alternative should be preferable, it is implied that the customers did not like both disjuncts and were likely not to pick either one. Here, both disjuncts are false, which matches the *neither...nor* interpretation, (36b). Participants were presented with one of the two variants of a story; the variants were distributed over two lists.[11]

(36) Certains clients n'aiment pas les pains au chocolat ou les
some client.PL NEG.like.3PL.PRS NEG DET.PL bread.PL at.the chocolate or DET.PL
croissants.
croissant.PL

a. Some clients either do not like chocolate bread or they do not like croissants.
b. Some clients like neither chocolate bread nor croissants.

(37) **Sample story for the *exclusive* interpretation:**

a. Dans ce café, on reçoit deux collations gratuites avec la boisson du matin: un pain au chocolat et un croissant. Récemment, les serveurs ont fait remarquer au

[11] See https://github.com/acochard/dissertation for the complete list of test sentences and stories.

manager que c'est parfois du gâchis parce qu'un groupe de clients réguliers laisse toujours l'une des deux collations sur la table.

b. At this cafe, you receive two free snacks with your coffee in the morning: a chocolate bread and a croissant. Recently, the staff told management that they think this can be wasteful, since a group of regular customers always leaves one of the pastries on their plates.

(38) **Sample story for the *neither...nor* interpretation:**

a. Dans ce café, on reçoit une collation gratuite avec la boisson du matin. On peut choisir entre un pain au chocolat et un croissant. Récemment, les serveurs ont demandé au manager s'ils pouvaient proposer une troisième option moins sucrée comme des fruits, parce qu'un groupe de clients soucieux de leur santé se plaint toujours du choix proposé.

b. At this cafe, you receive a free snack with your coffee in the morning. You can choose between a chocolate bread and a croissant. Recently, the staff asked management if they could add a healthy fruit alternative for a group of health-conscious customers, since they always complain about the lack of options.

The pair of test sentences was presented in two distinct prosodic variants. The first variant, the *OR Prosody*, was designed to enforce the *exclusive* interpretation by incorporating a clear prosodic break within the disjunctive phrase. This was achieved through a rising pitch on the first disjunct, followed by a pause of 400 ms before the disjunctive connective *ou* ("or"), as illustrated in Figure 8. The rest of the disjunctive phrase started with a high pitch and then fell toward the end of the sentence. The second variant, the *NEG Prosody*, was designed to enforce the *neither...nor* interpretation which was done by emphasising negation, following Surányi and Gulás (2022). However, this was not achieved by a pitch rise on negation, which sounded unnatural to our French native informants. Instead, we introduced a pause of 400 ms immediately after negation, between the verbal phrase and the disjunctive phrase, as illustrated in Figure 9. The latter was uttered as one single prosodic unit with a neutral pitch. In both contours, the length of the pause was manipulated in such a way that it was noticeable without sounding unnatural.

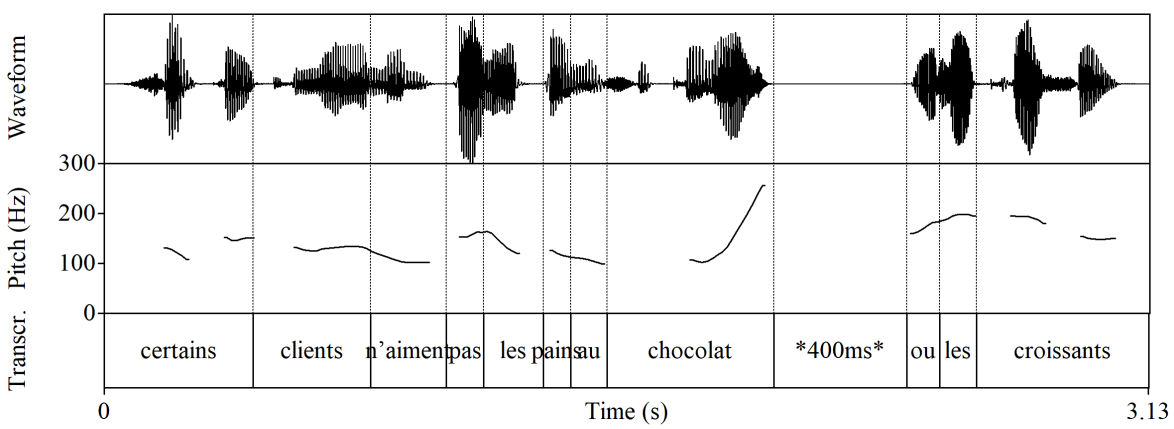


Figure 8: Pitch contour for the test sentence targeting the *exclusive* interpretation, that is the *OR Prosody*.

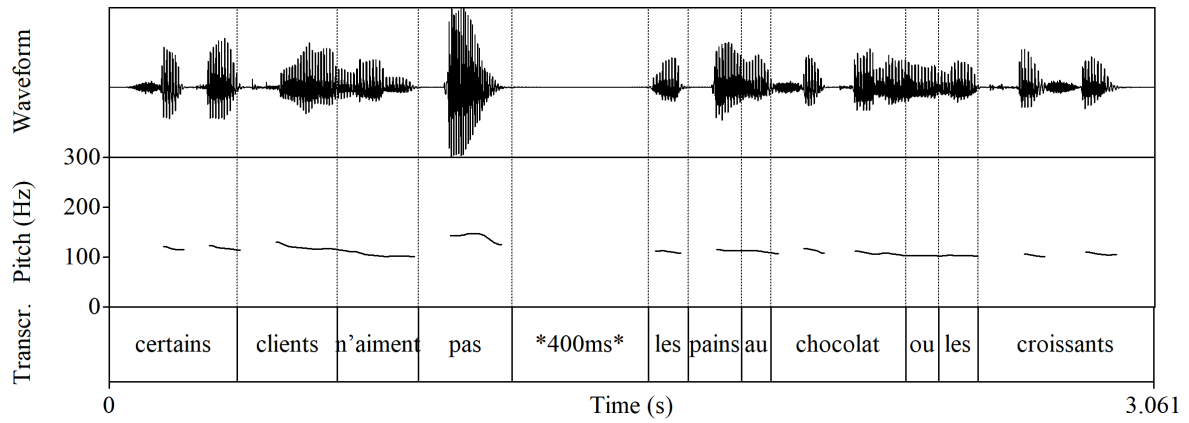


Figure 9: Pitch contour for the test sentence targeting the *neither...nor* interpretation, that is the *NEG Prosody*.

In addition to the twelve critical items, twelve filler items were included that served the purpose of filtering out participants who did not pay attention to prosody. Similar to the critical items, each filler sentence had two prosodic variants: one bearing subject focus and another with verb/object focus. The story made sure that one of the two prosodies was perceived as completely natural while the other was not. To illustrate, for the story in (39), the associated test sentence in (40) is acceptable with subject focus (40a) but not with verb/object focus (40b). Subject focus emphasises the subject, introducing new and unexpected information (here, the surprise was that it was a teacher who had been using drugs as opposed to someone else, a student). Conversely, for verb/object focus, emphasis is placed on the verb phrase (here, a teacher was consuming drugs instead of something else, which does not match the story); (41) and (42) illustrate an item where verb/object focus felicitous. In total, six filler items enforced subject focus, and the six other ones enforced verb/object focus.

(39) **Sample story for the subject focus prosody:**
   a. Notre prof a entendu dire qu'un de ses étudiants se droguait. Mais lorsque les dernières nouvelles sont tombées, elle a été très surprise.
   b. "The teacher had heard a while ago that one of her students had used drugs. But when she heard the latest news, she was stunned."

(40) En fait, un autre prof prenait de la drogue.
in fact DET.INDF other teacher take.3SG.IMPF.PST of the drug
"In fact, another teacher was taking drugs."
   a. **Subject focus:**
   En fait, UN AUTRE PROF prenait de la drogue.
   b. **Verb/Object focus:**
   En fait, un autre prof PRENAIT DE LA DROGUE.

(41) **Sample story for the verb/object focus prosody:**
   a. L'affiche du prochain spectacle de cirque disait qu'un chimpanzé jouerait de la trompette lors de son numéro. Mais cela n'était pas tout à fait vrai.
   b. "In the circus ad, it said that their chimpanzee would play the trumpet during the performance. But it turned out not to be completely true."

(42) En fait, le chimpanzé a joué du piano pendant son numéro.
in fact DET.M.SG chimpanzee AUX.3SG.SG play.PART.PST while his show

"In fact, the chimpanzee played piano during his show."

a. **Subject focus:**
   En fait, LE CHIMPANZÉ a joué du piano pendant son numéro.
b. **Verb/Object focus:**
   En fait, le chimpanzé A JOUÉ DU PIANO pendant son numéro.

Before critical and filler items were presented, a training phase of five items was implemented after the instructions to familiarise participants with the task. For training items, the two prosodic variants consisted of a declarative intonation and an interrogative one, which only differed by the presence or absence of a rising pitch at the end of the sentence, respectively. For instance, the story in (43) is compatible with a question as a continuation. Therefore, participants were expected to select the interrogative variant in (44) rather than a declarative one.

(43) **Sample story for the training:**

a. Eva s'apprête à recevoir la note d'un examen difficile qu'elle a passé il y a deux semaines. Son prof ne met en ligne les notes qu'à 23h30 au dernier moment. Le lendemain matin, quand Eva a vu sa mauvaise note, elle a été très déçue. Son père a tout de suite remarqué que quelque chose n'allait pas et il lui a demandé:
b. "Eva is about to receive a grade from a difficult exam she took two weeks ago. Her teacher only uploads the grades at 11:30 last minute. The next morning, when Eva saw her bad grade, she was very disappointed. Her father immediately noticed something was wrong and asked:"

(44) Tu n'as pas réussi l'examen ?
You NEG.AUX.2SG.PRS NEG succeed.PART.PST the.exam
"You did not pass the exam?"

Participants were not given feedback on training items. Participants who failed the training session (giving the incorrect response for more than two items) were offered the same five training items again. Failure to correctly do the training twice automatically excluded the participant from the study.

In total, participants saw 29 items (12 criticals, 12 fillers and 5 training items), all presented in one session of approximately 10 minutes. All items were compiled into four pseudo-randomised lists, which prevented critical items from immediately following another critical item. Moreover, there were never more than two items of the same condition in a row. The order (first/second) and position (left/right) in which each prosodic contour was played in a trial was counterbalanced so that participants could not associate a key to a specific contour.

4.2 Results

Group results and mixed model analyses are reported in Section 4.2.1 and individual analyses in Section 4.2.2. Section 4.2.3 reports an exploratory analysis of reaction times. Exclusion of participants from analysis was determined on the basis of their performance on the fillers (max three errors out of twelve items). After exclusion, 34 participants (range = 19-62, M = 33) were included in the analysis.

4.2.1 Group results

Statistical analyses were done within the R environment (R Core Team, 2023). Mixed models were computed using the *lme4* package (Bates et al., 2015) to fit linear mixed models.

Figure 10 reports the proportion of selection of each prosodic contour for type of story.[12] A clear difference appears between the *exclusive* stories and *neither...nor* stories. In *exclusive* stories, participants showed a higher proportion of selection of the *OR Prosody* (70.58% for the *OR Prosody* vs. 29.42% for the *NEG Prosody*), while in *neither...nor* stories this tendency was reversed (16.67% for the *OR Prosody* vs. 83.33% for the *NEG Prosody*).

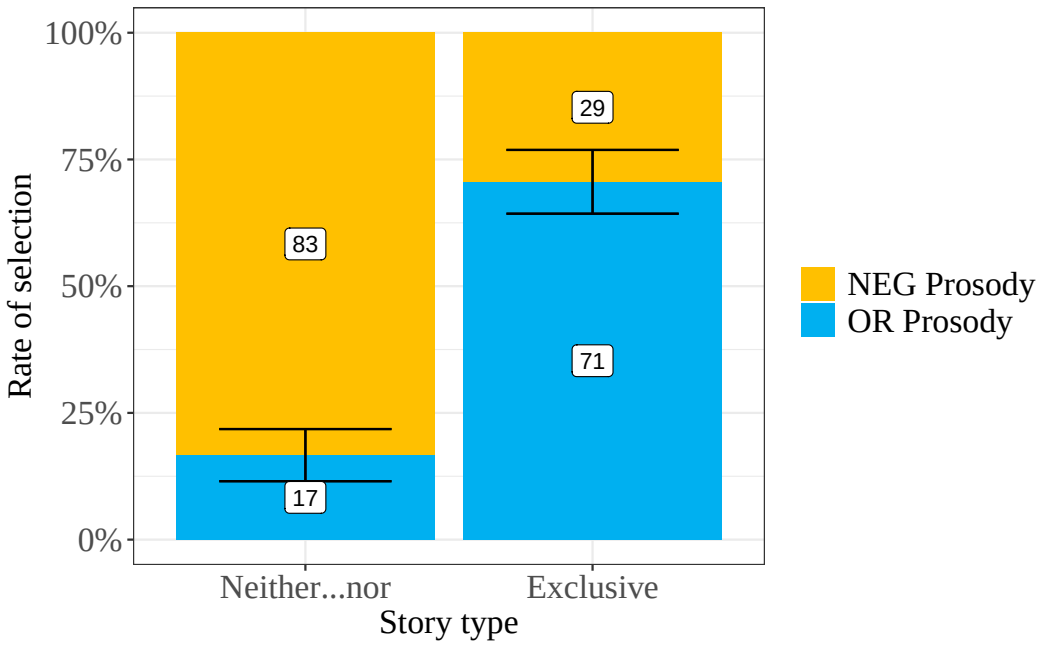


Figure 10: Proportion of selection of each prosodic contour for the *neither...nor* and *exclusive* story types. Whiskers represent a confidence interval of 95%.

To determine whether the difference between *exclusive* and *neither...nor* stories was a key factor in selecting one or the other prosody, a mixed effects modelling approach was adopted, using the *glmer* function from the *lme4* package. The binary responses from participants (choice of *OR Prosody* vs. *NEG Prosody*) were regressed against the type of story (*exclusive* story vs. *neither...nor* story). Random effects were included for participants and items to account for individual variation.[13] Additionally, a random slope of Story Type was incorporated into the participant-level random effect to model variation in responses across the two conditions. The coefficients of the model are reported in Table 2.

Predictor	**Estimate** (β)	**SE**	z	p
Intercept	−1.75	0.27	−6.37	$< .001^{***}$
Exclusive Story	2.89	0.39	7.46	$< .001^{***}$

Table 2: Coefficients of the model regressing the preference against the Story Type. Formula: $preference \sim story\_type + (1 + story\_type|\ participants) + (1\ |\ items)$

The model revealed a main effect of Story Type, suggesting that the interpretation that was enforced in a story was a key factor in choosing one or the other prosody. The predicted probabilities of preference based on the fixed effects of the model showed that the probability

[12] See Table B.1 in Appendix B for the complete descriptive statistics.

[13] We kept the random effect term for items by hypothesis but note that a likelihood ratio test showed that the inclusion of this term in the model structure did not especially improve it ($\chi^2(1) = 0.7199$, $Pr(>\chi^2) = 0.3962$).

of choosing the *OR Prosody* was 76% when the story was of the *exclusive* type, decreasing to 15% when the story was of the *neither...nor* type. Conversely, the probability of choosing the *NEG Prosody* was 85% for *neither...nor* stories, decreasing to 24% for *exclusive* stories. In other words, participants distinguished between the two prosodic contours based on the targeted interpretation in the story.

Story type	**Probability of choosing the...**	
	OR Prosody	NEG Prosody
Exclusive	75.9% [63.4% - 85.1%]	24.1% [14.9% - 36.6%]
Neither...nor	14.8% [9.2% - 23.0%]	85.2% [77.0% - 90.8%]

Table 3: Probabilities of choosing either of the two prosodic contours depending on the story type. Confidence intervals in brackets.

4.2.2 Individual results and cluster analysis

To assess whether participants were consistent in their responses, we aggregated their responses into a score ranging from 0 to 6 for each story type. Taking the *OR Prosody* as a baseline, the score indicates how frequently a participant selected this contour. For instance, a score of 1 means that the participants selected once the *OR Prosody* and 5 times the *NEG Prosody*. Figure 11 reports the number of participants per score and story type.

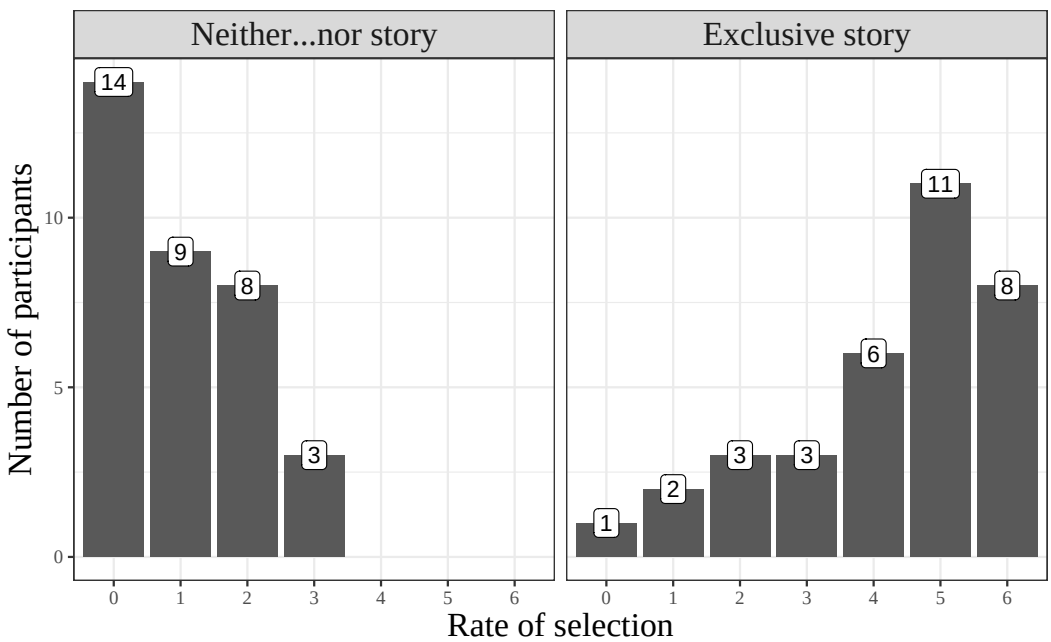
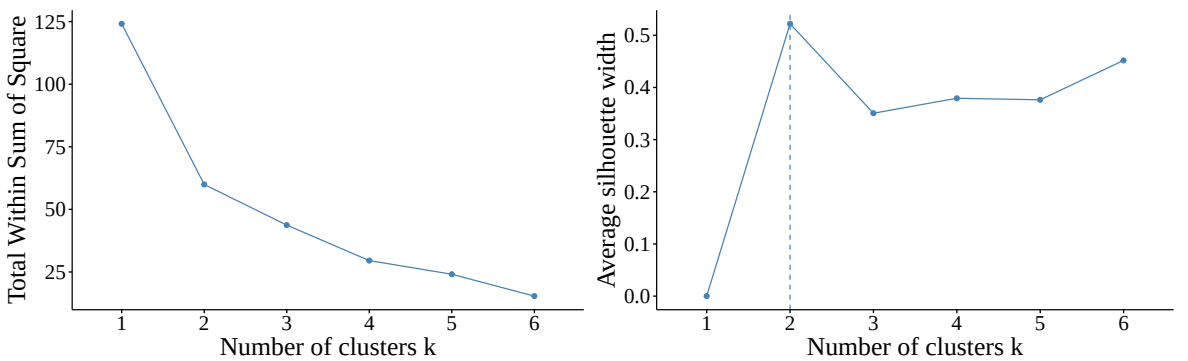


Figure 11: Distribution of participants based on the selection rate of the *OR Prosody* for each story type (e.g. 3 means that the participants selected the *OR Prosody* 3 times out of 6 items).

Figure 11 shows that most participants are located on either side of the graph, meaning that they tended to consistently select one or the other prosody. For the *neither...nor* stories (left panel of Figure 11), the majority of participants (23/34; 68%) preferred the *NEG Prosody* by selecting this contour 5 to 6 times out of 6 items. Moreover, no participants showed a preference for the *OR Prosody* in *neither...nor* stories. The *exclusive* stories (right panel of Figure 11) present the mirror image: a good half of the participants (19/34; 56%) preferred the

OR Prosody by selecting this contour 5 to 6 times out of 6 items. Notice that a handful of participants (3/34; 9%) showed a preference for the other, *NEG Prosody* as they selected the *OR Prosody* 1 or 2 times out of 6 items.

To examine the individual patterns more in depth, we adopted a clustering approach. The *cluster* (Maechler et al., 2025) and *factoextra* packages (Kassambara & Mundt, 2020) were used to define and visualise the optimal number of clusters in the dataset. Furthermore, a k-medoids algorithm[14] (Kaufman & Rousseeuw, 1990) was used to identify clusters, iterated 500 times to ensure the robustness of the output. The optimal number of clusters was determined by visualising the within-cluster sum of squares (WCSS) and using the heuristic elbow method. The "elbow" represents the cut-off point where increasing the number of clusters does no longer significantly decrease the WCSS value, which generally appears as an angle in the curve. In Figure 12a, the elbow curve indicates that two is the optimal number of clusters. This number was double checked by computing a silhouette score to evaluate the clustering quality, illustrated in Figure 12b. The silhouette score measures how distant a data point is from its own cluster in comparison to the other clusters. The higher the score, the better the clustering algorithm is. As for the elbow curve, the silhouette score is maximized at two clusters and decreases with any higher number of clusters.



(a) Elbow curve (WCSS) **(b)** Silhouette score

Figure 12: Optimal number of clusters using the "elbow" method and the silhouette score.

Additionally, an anomaly detection algorithm was run to identify any data points whose mean was too distant from a threshold that was computationally defined beforehand.[15] By identifying outliers, we could identify participants whose median was too distant from the median of their respective cluster, and, as such, less likely to really belong to this cluster. In our data, this either corresponded to participants showing at-chance performance (e.g., accepting or rejecting a condition 3 times out of 6), or to consistent but isolated participants.

The properties of the two clusters are reported in Table 4 and plotted in Figure 13. In

[14] For this study, we employed the k-medoids clustering algorithm (Kaufman & Rousseeuw, 1990) rather than the k-means one (MacQueen, 1967) as the latter is more sensible to dispersed data and outliers. Since the prior examination of the individual results showed that participants selecting one prosody were scattered around three score values (e.g. 4, 5 and 6 in the right panel of Figure 11) rather than around one, a k-medoid approach seemed more adapted. See Chapters 3 and 5 for an application of the k-means clustering algorithm.

[15] Outliers are data points that appear to be inconsistent with the rest of the data. For instance, in a scatter plot, outliers would be settled far away from their neighbourhood. In this study, outliers were detected using a distance-based approach (Angiulli et al. 2009; Knorr and Ng 1998; Orair et al. 2010; Ramaswamy et al. 2000; see Vinces et al. 2025 for a recent review of clustering based outlier detection techniques). To this effect, a threshold was computationally defined (*[maximum distance − minimum distance] / 2*; Barai (Deb) and Dey 2017). Every data point whose distance from the centre of its cluster was above the threshold was considered as an outlier.

Cluster 1, participants systematically preferred the *OR Prosody* in *exclusive* stories and the *NEG Prosody* in *neither...nor* stories. This pattern included the majority of the participants (27 out of 34). Cluster 2, however, tells a different story. This group consists of participants who consistently chose the *NEG Prosody* regardless of the story type. Yet, given the high dispersion of data points and the fact that nearly half of the group consists of outliers (3/7; 43%), it is not possible to conclude that this cluster reflects a genuine preference for the *NEG Prosody*.

Cluster	Mean for each condition		Number of participants	
	Neither...nor story	Exclusive story	With outliers	Without outliers
#1	1	5	27	24
#2	2	2	7	4

Table 4: Median score of the selection rate of the *OR Prosody* for each cluster.

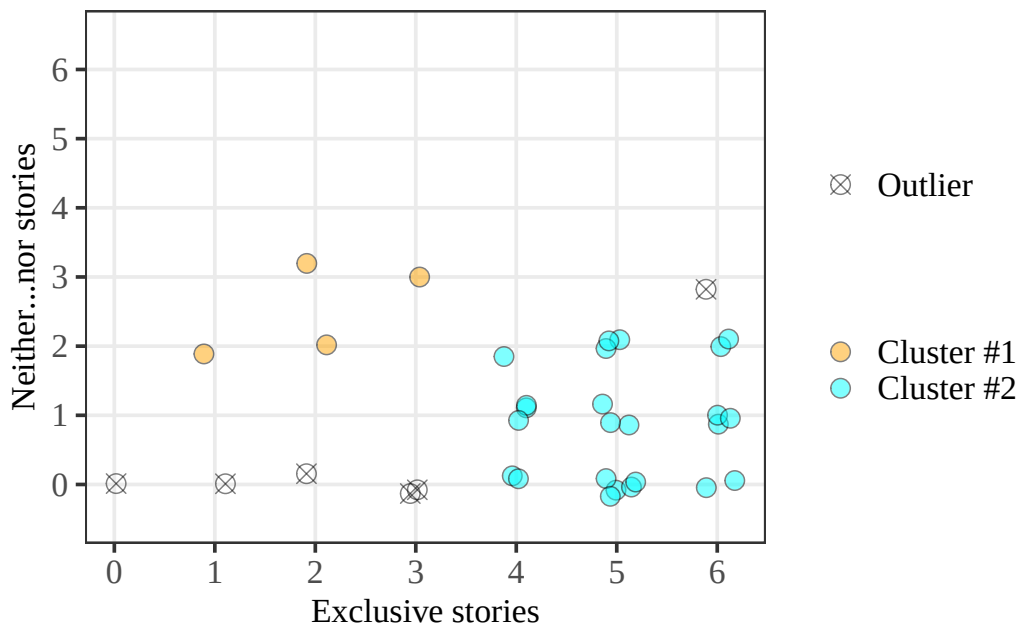


Figure 13: Distribution of participants' preference for the *OR Prosody* in both *exclusive* and *neither...nor* stories

4.2.3 Exploratory analysis of reaction times

To determine whether participants were faster in selecting one of the two prosodies for each story type, reaction times were recorded from the offset of the test sentence audio to the moment the participant pressed a key. Participants who responded exceptionally fast or slow were excluded using the interquartile range criterion (IQR); any data point beyond 1.5 times the IQR was considered as an outlier. The median reaction times for each combination of prosody and story type are reported in Table 5. The results revealed a contrast between *exclusive* and *neither...nor* stories. In *exclusive* stories, participants selected both prosodies at approximately the same pace (907 ms for the *OR Prosody* vs. 945 ms for the *NEG Prosody*). However, in *neither...nor* stories, participants were twice as fast at selecting the *NEG Prosody* (709 ms) compared to the *OR Prosody* (1461 ms).

Story type	Prosody	Median	IQR
Exclusive story	OR	907	1203
	NEG	945	936
Neither...nor story	OR	1461	1711
	NEG	709	881

Table 5: Median reaction times and IQR after outlier exclusion for each prosody, categorised by story type. Log transformed values were back-transformed into milliseconds for readability.

To determine whether the contrast identified in Table 5 is significant, a series of mixed effect models were computed using the *lmer* function from the *lme4* package (Bates et al., 2015). First, the log-transformed reaction times were regressed against Story Type (*exclusive* vs. *neither...nor* stories). Additionally, random effects of Participants and Items were incorporated in the model structure to account for individual variability. The coefficients of the model are reported in Table 6. Investigating next whether there was a difference in response time depending on whether participants selected the *OR Prosody* or the *NEG Prosody*, we fitted two models: one for each story type, whose coefficients are reported in Table 7 and 8,respectively.

Predictor	Estimate (β)	SE	t	p
Intercept	6.65	0.10	64.06	$< .001^{***}$
Exclusive Story	0.26	0.07	3.42	$< .001^{***}$

Table 6: Coefficients of the model regressing the log-transformed reaction times against the story type. Formula: *log(RT)* ~ *story_type* + *(*1 + *story_type* | *participants)* + *(*1 | *items)*

Predictor	Estimate (β)	SE	t	p
Intercept	6.98	0.13	−52.66	$< .001^{***}$
Preference OR	−0.11	0.13	−0.85	.399

Table 7: Coefficients of the model regressing the log-transformed reaction timed against the preference for the *exclusive* story type. Formula: *log(RT)* ~ *preference* + *(*1 | *participants)* + *(*1 | *items)*

The first model revealed a main effect of the story type: participants were slower in the *exclusive* stories than in the *neither...nor* stories. The two other models revealed that participants were neither faster nor slower in *exclusive* stories. In *neither...nor* stories, however, participants were significantly slower when the prosodic contour did not match the story type. Since preference is an outcome rather than a manipulated variable, these conclusions should be interpreted with caution.

4.3 Summary of findings

Study 1 investigated whether a particular interpretation of negated disjunction was associated with a specific prosodic contour. The results provided robust evidence that participants' prosodic preferences are systematically influenced by interpretation, which was manipulated here with the two types of stories. At the group level, mixed-effects models showed a main effect of Story Type: participants consistently selected the *OR Prosody* in *exclusive* stories and

Predictor	Estimate (β)	SE	t	p
Intercept	6.57	0.12	55.86	$< .001^{***}$
Preference OR	0.49	0.16	3.05	$.002^{**}$

Table 8: Coefficients of the model regressing the log-transformed reaction timed against the preference for the *neither...nor* story type. Formula: *log(RT) ~ preference + (1 | participants) + (1 | items)*

the *NEG Prosody* in *neither...nor* stories, with probabilities of 76% and 85%, respectively. As for individual results, the cluster analysis revealed two distinct response patterns: one included participants who consistently distinguished the two interpretations with a particular contour (24/34 participants). The other cluster consisted of a mix of participants who seemed to either associate interpretation and prosodic contour at chance or to consistently prefer the *NEG Prosody* irrespective of the story type, though this seems to represent a handful of participants. Although exploratory, the reaction time analyses reinforced the finding that participants were sensitive to an interpretation-prosody association. Whereas there was no difference in selecting one or the other prosodic contour in the *exclusive* stories, they were significantly faster in selecting the *NEG Prosody* in the *neither...nor* stories. This asymmetry suggests that prosody matters, especially when participants need to assess the reading that is allegedly non-preferred in their language. Together, these findings highlight a clear and consistent mapping between interpretation and prosodic contour. This will be further investigated in Study 2.

5 Study 2: From prosody to interpretation

This section presents the second study of this chapter, which investigated the interpretation of negated disjunctive statements depending on the type of prosody. Section 5.1 details the methods and Section 5.2 reports the results.

5.1 Method

5.1.1 Participants

A total of 80 native French speaking adults (range = 21-69, M = 32) participated in the experiment. To be included in the study, participants had to be native French speakers from France with no self-declared cognitive, visual or hearing impairments. Participants were recruited using Prolific. Adults were paid £2.25 for a 15 minutes advertised experiment, complying with the recommended hourly rates set by Prolific.

5.1.2 Procedure

A truth-value judgement task in description mode (Crain & Thornton, 1998) was employed for this study. Participants had to judge a sentence, presented in the form of a guess, describing the outcome of a dining event. Participants were told that different animals would participate in a dinner in which they would be offered two types of food. The foods were not directly visible, hidden under covered plates, as illustrated in Figure 14. A side character, Bob the Alien, described to the participant what was under the plates using sentences such as (45a) and (45b).

(45) Il y a une pomme dans l'un des plats. Et une poire dans l'autre plat.

a. Il y a une pomme dans l'un des plats.
EXPL LOC AUX.3SG.PRS DET.INDEF apple in DET.DEF-one PART.DEF.PL dish-PL
"There is an apple on one of the plates."

b. Et une poire dans l'autre plat.
and DET.INDEF pear in DET.DEF-other dish
"And a pear on the other plate."

After the second introductory description (45a), a curtain fell down and hid the scene. Neither the participant nor Bob the Alien could see what was happening behind the curtain, as illustrated in Figure 15. The curtain served the purpose of ensuring that the ignorance inference tied to disjunction was satisfied. A few hundred of milliseconds later, a bell sound rang, signalling that the dining event was finished. Immediately after, the curtain rose and revealed the outcome, as shown in 16. Plates could appear in two states: covered or uncovered. Covered plates indicated that the animal did not like the food and did not eat it. Uncovered plates indicated that the animal liked the food that was on it and had eaten it. The design covered the full range of possibilities, from having the animal liking neither of the foods to liking only the first food, liking only the second food, and liking both foods. When the outcome picture appeared, Bob the Alien made a guess, such as (46), about the character's liking of the food. At the offset of the audio, participants were given the possibility to signal whether they agreed or disagreed with Bob's guess, by pressing either the "F" or "J" key (Figure 17).

(46) The penguin does not like the apple or the pear.

Importantly, since prosody was the main variable of interest, the critical visual stimulus (Figure 16) was presented simultaneously with the audio stimulus containing the test sentence. This timing was crucial because prosodic information can be difficult to retain and participants were not allowed to hear audio stimuli again. Thus, it was essential to avoid any delay between hearing the sentence and seeing the image revealing how many foods were liked. As a result, we could not use the prediction mode of the truth-value judgement task. One potential concern with using the description mode is that it might violate potential ignorance inferences associated with disjunction (if disjunction scopes over negation). However, in our experimental design, the outcome described by the character was never actually revealed. That is, the participants were not provided with information about which disjunct was true or false, thereby preserving the conditions under which ignorance inferences arise.

To prevent confusion and align with the keyboard layout, the "F" and "J" keys always appeared on the left and right sides of the picture, respectively. The position of the "Agree" and "Disagree" signs, however, were counterbalanced across participants. Furthermore, reaction times were recorded from the offset of the recording of Bob's guess to the moment participants pressed "F" or "J". Participants were not allowed to replay the recordings and were instructed to follow their intuition when making their selection. Before the experiment, participants completed a short questionnaire regarding their age, dominant hand, and whether they had any other native languages besides French.

The experiment was conducted online, using OpenSesame to compile the script (Mathôt et al., 2012; Mathôt & March, 2022) and a private JATOS server (Lange et al., 2015) to host the experiment and the data.

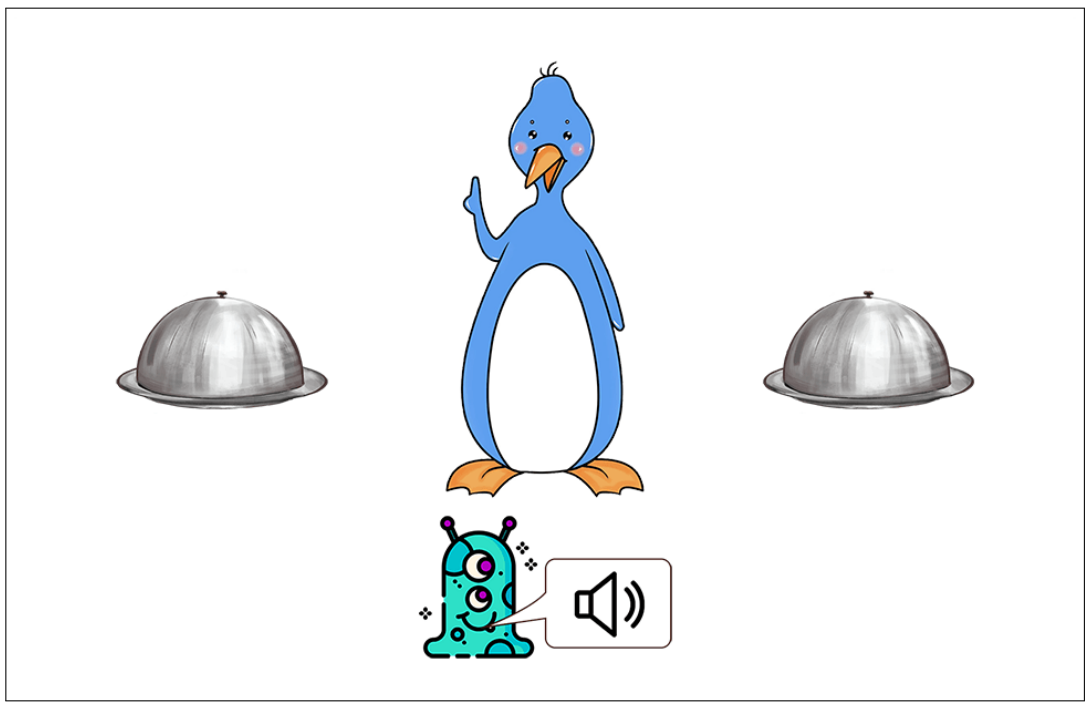


Figure 14: Sample trial, first phase: Bob the Alien introduces the foods under the plates.

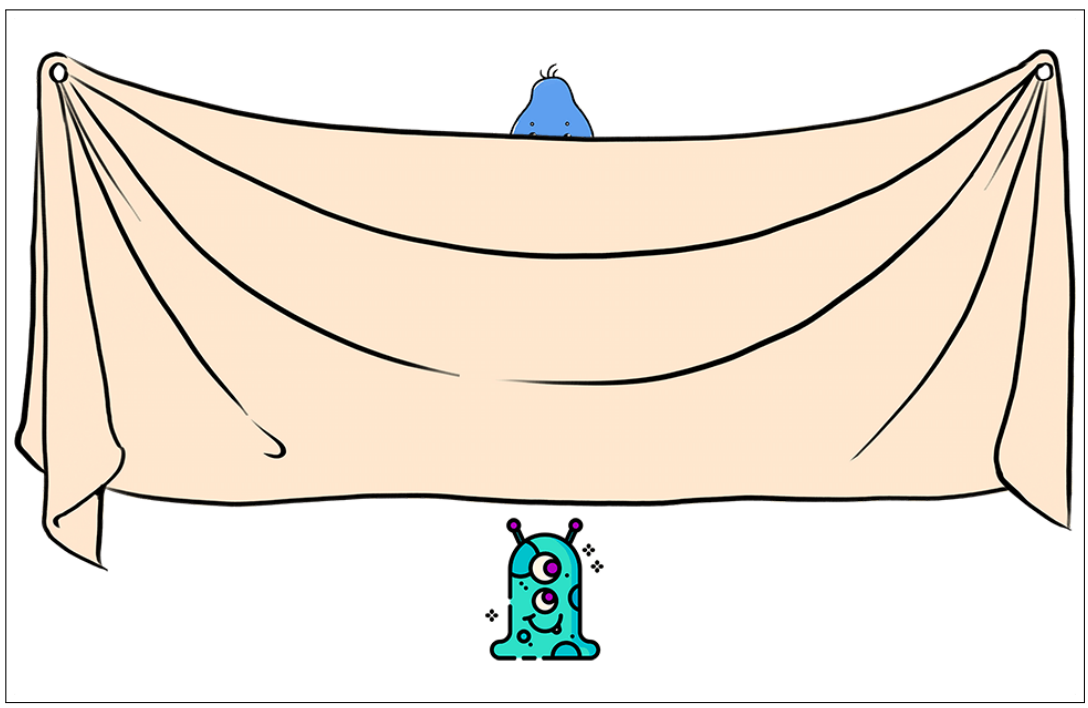


Figure 15: Sample trial, second phase: A curtain hides the dining event from Bob the Alien and the participant. A bell sound indicates that the dinner is over and the curtain rises.

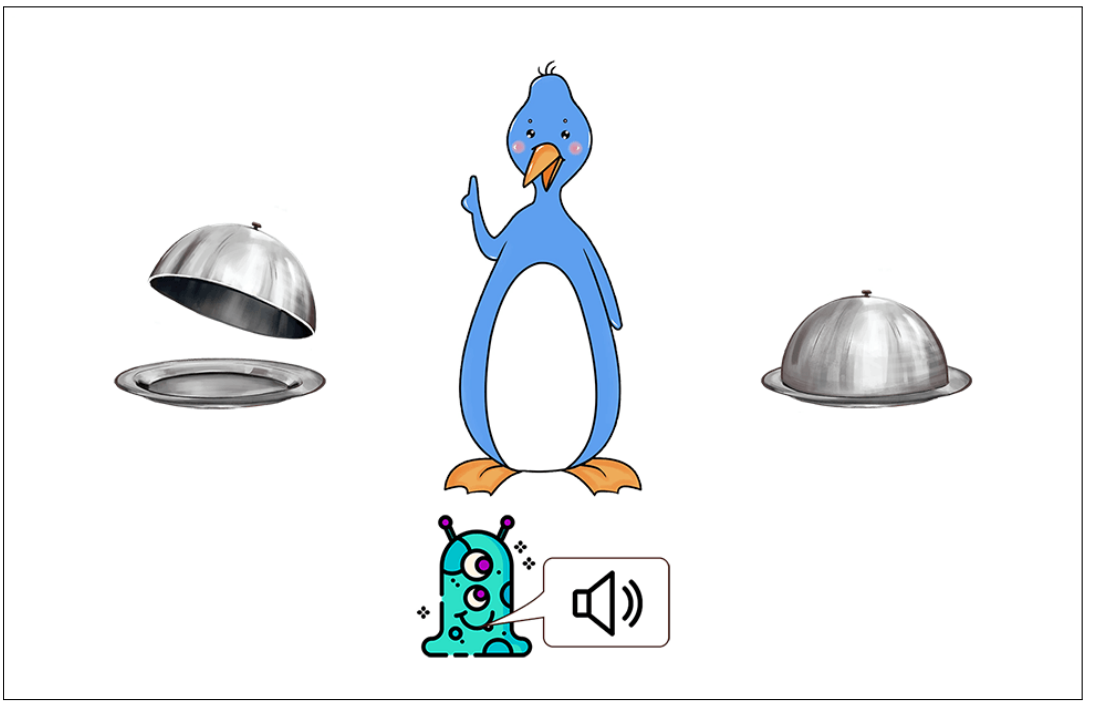


Figure 16: Sample trial, third phase: Bob the Alien guesses what the penguin likes based on the pictures of the plates.

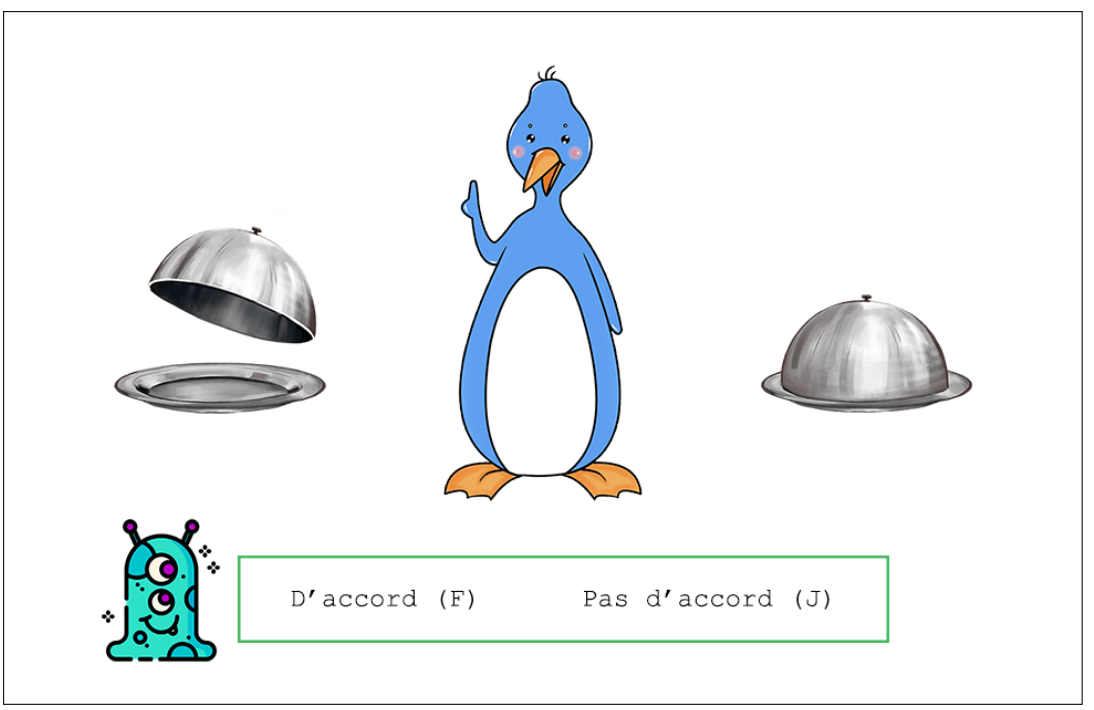


Figure 17: Sample trial, fourth phase: The participant is prompted to indicate whether she agrees with Bob's guess or not by pressing either "F" or "J". Translation: "D'accord" means "Agree"; "Pas d'accord" means "Not agree/Disagree".

5.1.3 Material and conditions

The design incorporated four critical conditions and two control conditions, structured in a 2×3 factorial design, as shown in Table 9. The conditions varied the type of prosody (*OR Prosody* vs. *NEG Prosody*) and the number of disjuncts true (*No Disjunct True*, *One Disjunct True* or *Two Disjuncts True*). The design was between-subjects: half of the participants were assigned to the *OR Prosody* condition while the other half was assigned to the other condition. Prosody was varied between subjects not only to avoid a longer experiment, but also to prevent any confusion between the two types of prosody. Each critical condition was presented 8 times and each control condition 4 four times (16 critical items, 4 controls, 20 items in total).

	 **No Disjunct True**	 **One Disjunct True**	 **Two Disjuncts True**
OR Prosody	Critical (8 items)	Critical (8 items)	Control (4 items)
NEG Prosody	Critical (8 items)	Critical (8 items)	Control (4 items)

Table 9: 2×3 factorial design of the experiment crossing the type of prosody and the number of disjuncts true.

In all conditions, participants assessed a negated disjunctive statement such as (47), presented in one of two prosodic variants: the *OR Prosody* and the *NEG Prosody*. As in Study 1, each prosodic contour was designed to prime a specific interpretation. The prosodic contours used in this experiment mirrored those from the first study: the *OR Prosody* featured a pitch rise on the first disjunct followed by a 400 ms pause before *ou* "or" (see Figure 8), while the *NEG Prosody* included a 400 ms pause after negation, followed by the disjunctive phrase uttered as a single prosodic unit with a neutral tone (see Figure 9).

(47) Le pingouin n'aime pas la pomme ou la poire.
DET penguin NEG-like.3SG.PRS NEG DET apple or DET pear
"The penguin does not like the apple or the pear."

In Study 1, we confirmed that a specific interpretation could be associated with a prosodic contour. If the reverse is true, that is, if prosody is a determining factor in interpreting negated disjunctive statements, then we expect different responses to Bob's guess depending on whether the negated disjunctive statement is uttered with an *OR Prosody* or a *NEG Prosody*. Table 10 summarises the corresponding predictions.

	 **No Disjunct True**	 **One Disjunct True**	 **Two Disjuncts True**
OR Prosody	Rejection	Acceptance	Rejection
NEG Prosody	Acceptance	Rejection	Rejection

Table 10: Predicted answer patterns for each prosody type.

Upon hearing an *OR Prosody*, participants were expected to reject situations where no

disjunct is true and accept situations where only one disjunct is true, i.e. the *exclusive* interpretation. Conversely, upon hearing a *NEG Prosody*, participants were expected to show the reverse answer pattern, accepting situations where no disjunct is true and rejecting situations where only one disjunct is true, i.e. the *neither...nor* interpretation.

Finally, 36 filler items served the purpose of balancing the number of yes and no-responses. These fillers either included a positive conjunctive statement (48) or a unambiguous statement such as (49) and (50). Fillers plus controls together served to exclude participants who did not pay attention or did not understand the task.

(48) Le pingouin aime le chocolat et le citron aussi.
det penguin like.3SG.PRS DET chocolate and DET lemon also
"The penguin likes chocolate and lemon too."

(49) Le pingouin aime les deux.
DET penguin like.3SG.PRS DET.PL both
"The penguin likes both."

(50) Le pingouin aime le chocolat mais pas le citron.
DET penguin like.3SG.PRS DET chocolate but NEG DET lemon
"The penguin likes chocolate but not lemon."

All items were compiled into four pseudo-randomised lists, preceded by 8 training items which were similar to the fillers. Participants who answered more than two training items incorrectly were not permitted to proceed with the experiment. In total, participants saw 64 items (16 critical, 4 controls, 36 fillers and 8 training) in one session.

5.2 Results

Group results and mixed model analyses are reported in Section 5.2.1 (see Section 4.2.1 for details about the statistical environment), the analysis of individual results in Section 5.2.2, and an exploratory analysis of reaction times in Section 5.2.3. Exclusion of participants from analysis was determined according to their performance on controls and fillers. Participants were not allowed to make more than four errors out of the 40 fillers and controls (36/40; 90%). After exclusion, 38 participants assigned with the *OR Prosody* (range = 21-69, M = 33) and 38 participants assigned with the *NEG Prosody* (range = 22-52, M = 32) were included in the analysis.

5.2.1 Group results

The mean acceptance rates for each critical condition categorised by prosody type is reported in Figure 18.[16] At first glance, the acceptance patterns for the two prosodies appear to be mirror images of each other. In the *NEG Prosody* the *No Disjunct True* condition was mostly accepted (79%) whereas the *One Disjunct True* condition showed mixed acceptance (46%). Conversely, the *OR Prosody* condition showed the opposite pattern: the *One Disjunct True* condition was mostly accepted (71%) whereas the *No Disjunct True* condition showed mixed acceptance (47%). Mixed acceptance could indicate that participants were responding at chance, or alternatively, that they were consistent, but exhibited distinct interpretative preferences. This is investigated in Section 5.2.2.

To compare the performance between each Prosody Type, a mixed effects modelling

[16] See Table B.2 in Appendix B for the complete descriptive statistics.

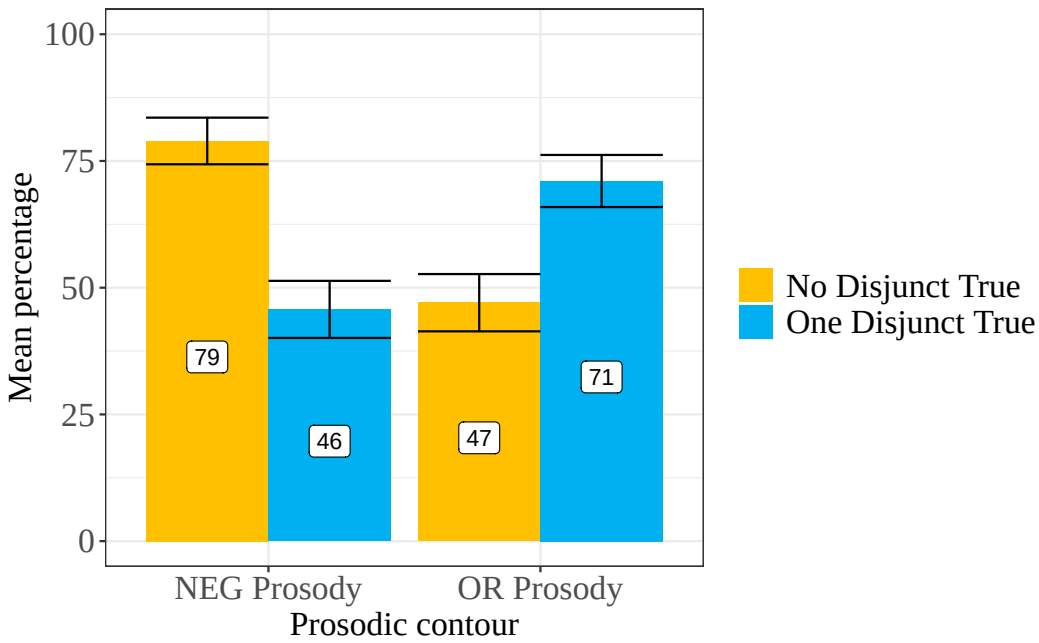


Figure 18: Mean percentage of acceptance per condition for each prosody type. Whiskers represent a confidence interval of 95%.

approach was adopted, using the *glmer* function from the *lme4* package. The binary responses (yes or no) were regressed against the conditions (*No Disjunct True* and *One Disjunct True*), the Prosody Type (*OR Prosody* vs. *NEG Prosody*) and the interaction between the two. Random effects were included for participants and items. Additionally, a random slope of the condition was added to the participant random effect to model variation in responses across conditions. The coefficients of the model are reported in Table 11.

Predictor	**Estimate (β)**	**SE**	z	p
Intercept	2.56	0.54	4.71	$< .001^{***}$
One Disjunct True	−3.51	1.27	−2.77	$.005^{**}$
OR Prosody	−2.84	0.75	−3.81	$< .001^{***}$
One Disjunct True × OR Prosody	6.65	1.83	3.62	$< .001^{***}$

Table 11: Coefficients of the model regressing the participants' response against the conditions and the type of prosody. Formula: *answer* ~ *nb_of_disjuncts_true* * *prosody_type* + *(1 + nb_of_disjuncts_true | participants)* + *(1 | items)*

The model revealed a main effect of the number of disjuncts true and the type of prosody. Moreover, the model also showed a significant interaction between the number of disjuncts true and the type of prosody. To further explore the contrasts between the two groups and quantify differences in their responses, we proceeded to post-hoc pairwise comparisons, reported in Table 12. The comparisons revealed that the *No Disjunct True* condition was accepted significantly more often with *NEG Prosody* than with *OR Prosody*, while the *One Disjunct True* condition was accepted significantly less often with *NEG Prosody* than with *OR Prosody*. Additionally, within the *NEG Prosody* group, the *No Disjunct True* and the *One Disjunct True* conditions were significantly different, and the same pattern was observed within the *OR Prosody* group, where the *No Disjunct True* and the *One Disjunct True* condition also differed significantly.

Contrast		Estimate (β)	SE	z	p
NEG Prosody vs. OR Prosody	No Disjunct True	2.84	0.74	3.81	$< .001^{***}$
	One Disjunct True	−3.81	1.30	−2.93	$.003^{**}$
No Disjunct True vs. One Disjunct True	NEG Prosody	3.51	1.27	−2.78	$.006^{**}$
	OR Prosody	−3.14	1.28	−2.46	$.014^{*}$

Table 12: Post-hoc pairwise comparisons (between and within group contrasts).

5.2.2 Individual results and cluster analysis

Having seen in Section 5.2.1 that there was a mixed acceptance depending on the type of prosody and the number of disjuncts true, the number of yes-answers of each participant was aggregated into a score ranging from 0 to 8 for each condition, where 0 means that the participant consistently rejected the condition and 8 that she consistently accepted it. The distribution of these scores for each condition is presented in Figure 19 for the group assigned to the *OR Prosody*, and Figure 20 for the group assigned to the *NEG Prosody*.

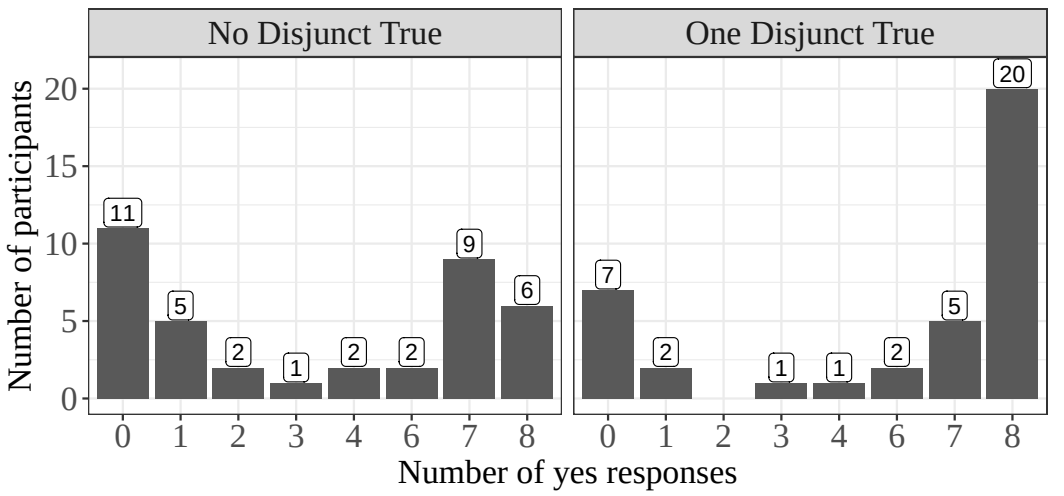


Figure 19: Distribution of the score value across conditions (0 to 8 out of 8 acceptance) for the group assigned with the *OR Prosody*.

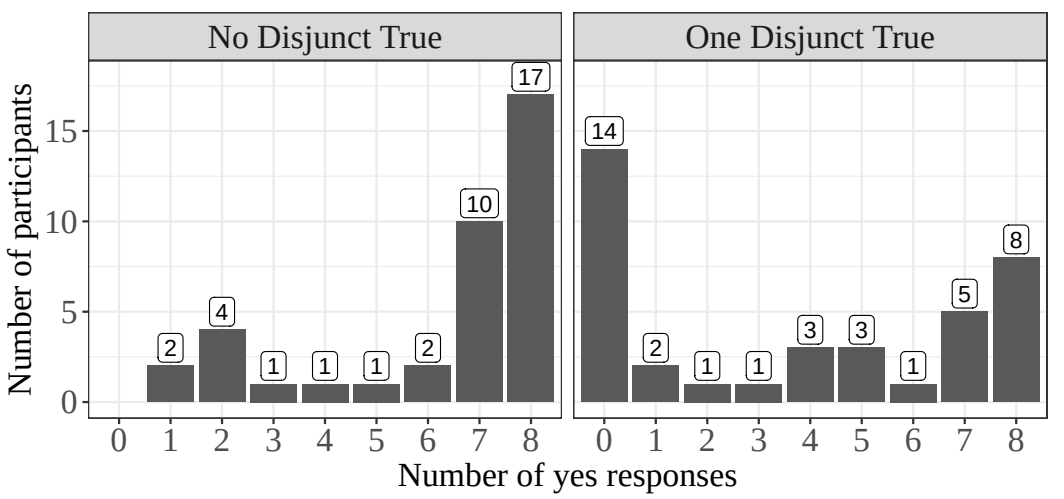
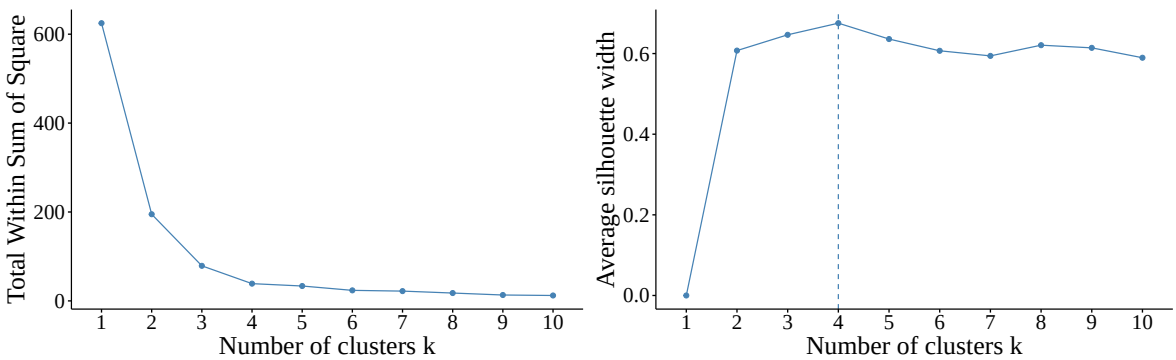


Figure 20: Distribution of the score value across conditions (0 to 8 out of 8 acceptance) for the group assigned with the *NEG Prosody*.

Figure 19 shows that most participants who were assigned the *OR Prosody* either fully accepted a condition or rejected it. This suggests a bimodal distribution where participants might have consistently rejected a condition while accepting the other. Figure 20 tells an almost similar story. While participants who were assigned the *NEG Prosody* split into two groups in the *One Disjunct True* condition, it appears that a majority of participants consistently accepted the *No Disjunct True* condition. To determine whether these responses formed cohesive patterns, we again adopted a clustering approach (see Section 4.2.3 for details about the method).

Using the "elbow" method (Figure 21a) and the silhouette score (Figure 21b), the optimal number of clusters for the group who was assigned the *NEG Prosody* was set to 3.[17]



(a) Elbow curve (WCSS) **(b)** Silhouette score

Figure 21: Optimal number of clusters using the "elbow" method and the silhouette score for the *NEG Prosody* group.

The properties of the three clusters for the *NEG Prosody* group are reported in Table 13 and their distribution is illustrated in Figure 22. In the first cluster (top right corner of Figure 22), participants accepted both the *No Disjunct True* and *One Disjunct True* conditions, which corresponds to a *not both* interpretation of negated disjunctive statements. The second cluster (bottom right corner of Figure 22) is composed of participants rejecting the *No Disjunct True* condition but accepting the *One Disjunct True* condition, showing an *exclusive* interpretation of the test sentence. These two clusters together include approximately half of the participants. The third cluster (top left corner of Figure 22) consists of the other half. Participants belonging to this cluster consistently accepted the *No Disjunct True* condition while rejecting the *One Disjunct True* condition, which reflects the *neither...nor* interpretation.

Cluster	Median for each condition		Number of participants	
	No Disjunct True	One Disjunct True	With outliers	Without outliers
Not both	8	7	11	6
Exclusive	2	7	9	6
Neither...nor	8	0	18	15

Table 13: Median score of the two critical conditions by cluster in the *NEG Prosody* group.

[17] To clear the uncertainty between 3 and 4 clusters in Figure 21a and Figure 21b, we ran the *nbClust* function from the *nbClust* package (Charrad et al., 2014) which returned 3 at the optimal number of clusters on 12 indices.

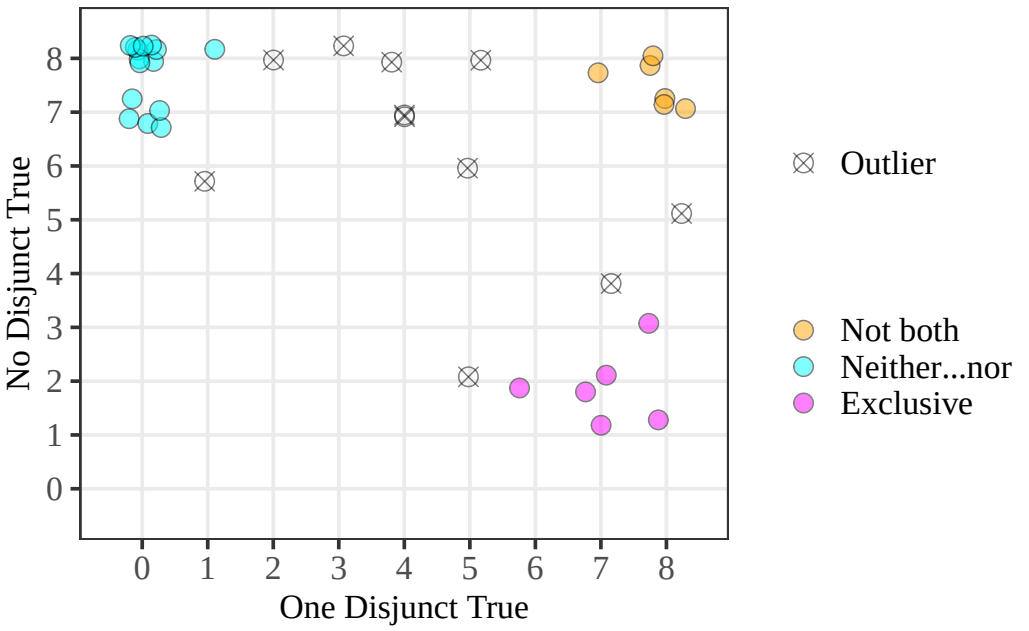
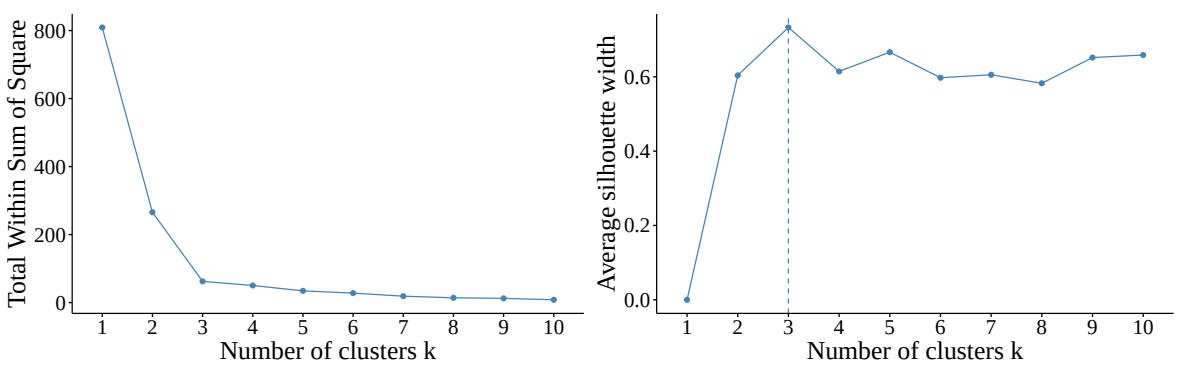


Figure 22: Response patterns of participants in the *NEG Prosody* group, categorised by cluster, across the *No Disjunct True* and *One Disjunct True* conditions.

For participants who were assigned the *OR Prosody*, the "elbow" method (Figure 23a) and the silhouette score (Figure 23b) returned 3 as the optimal number of clusters.

The properties of these clusters for the *OR Prosody* group are reported in Table 14 and their distribution is illustrated in Figure 24. In the first cluster (top right of Figure 24), participants tended to consistently accept both conditions, showing the *not both* interpretation of negated disjunction. In the second cluster (top left corner of Figure 24), participants consistently accepted the test sentence in the *No Disjunct True* condition but rejected it in the *One Disjunct True* condition. These participants assigned a *neither...nor* interpretation to negated disjunction. As with the *NEG Prosody* group, these two patterns represent half of the *OR Prosody* participants. The remaining cluster (bottom right of Figure 24) is composed of the other half of the participants, who consistently accepted the *One Disjunct True* condition but rejected the *No Disjunct True* condition, assigning an *exclusive* interpretation.



(a) Elbow curve (WCSS) **(b)** Silhouette score

Figure 23: Optimal number of clusters using the "elbow" method and the silhouette score for the *OR Prosody* group.

Cluster	Median for each condition		Number of participants	
	No Disjunct True	One Disjunct True	With outliers	Without outliers
Not both	7	7	9	7
Exclusive	0	8	19	17
Neither...nor	8	0	10	9

Table 14: Median score of the two critical conditions by cluster in the *OR Prosody* group.

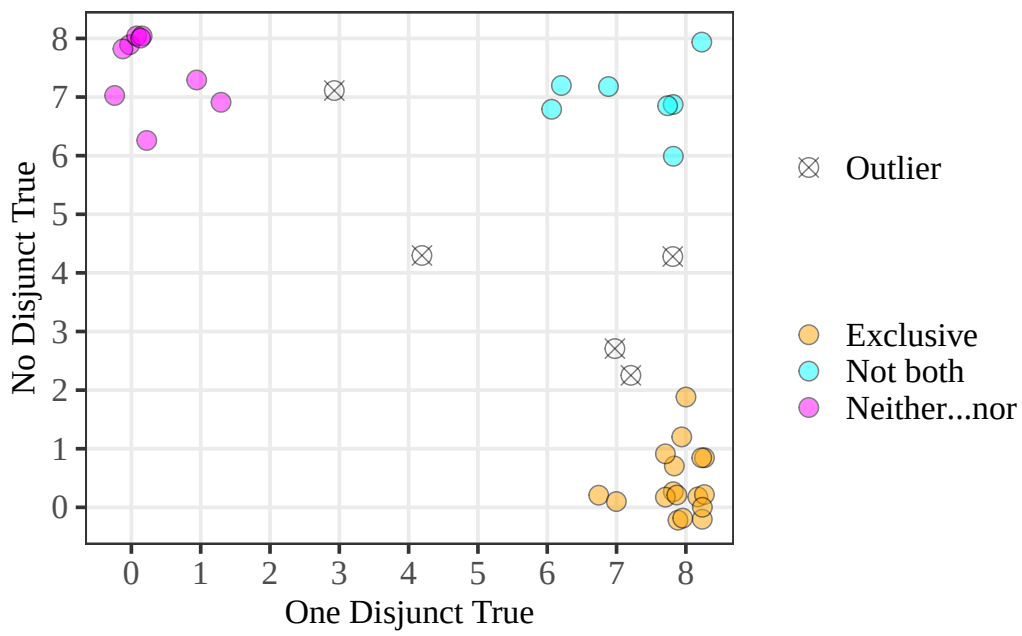


Figure 24: Response patterns of participants in the *OR Prosody* group, categorised by cluster, across the *No Disjunct True* and *One Disjunct True* conditions.

The results of the individual patterns, summarised in Table 15, lead to three key observations. First, the majority of participants presented with the *OR Prosody* derived an *exclusive* interpretation, while the majority of participants presented with the *NEG Prosody* derived a *neither...nor* interpretation. Second, regardless of the prosodic manipulations, some participants consistently showed the opposite interpretation of the target interpretation, e.g. showing the *neither...nor* interpretation when assigned with the *OR Prosody*, and, conversely, showing the *exclusive* interpretation when assigned with the *NEG Prosody*. Third, another group of participants consistently derived a *not both* interpretation, accepting both scenarios in which no and one disjunct were true.

In all, the proportions of *exclusive* versus neither nor interpreters varies depending on the type of prosodic contour. For the prosodic contour that was hypothesised to favour the *exclusive* interpretation, the largest proportion of participants were *exclusive* interpreters. Similarly, for the prosodic contour that was hypothesised to favour the neither nor interpretation, the largest proportion of participants were neither nor interpreters. This suggests that prosody had a clear effect on interpretation. Nevertheless, not all participants were sensitive to prosody in this way. There were also participants whose preference went for the other readings regardless of the prosodic contour. In particular, in the *OR Prosody* group, some people showed either

Pattern	OR Prosody	NEG Prosody
Exclusive	17 (51.5%)	6 (22.2%)
Not both	7 (21.2%)	6 (22.2%)
Neither...nor	9 (27.3%)	15 (55.6%)
	33 (100%)	27 (100%)

Table 15: Number of participants per consistent pattern and prosody type. 5 outliers removed for the *OR Prosody* and 11 outliers removed for the *NEG Prosody*.

a consistent *not both* interpretation and some others a *neither...nor* interpretation. In the *NEG Prosody* group, some people showed a *not both* interpretation and others an *exclusive* interpretation. These findings are unexpected under the assumption that French disjunction *ou* "ou" is a positive polarity item. We discuss these findings further in Section 6 and propose that the positive polarity status of the French disjunction *ou* should be reconsidered.

5.2.3 Exploratory analysis of reaction times

Reaction times were collected to detect whether participants responded faster or not depending on the prosodic contour. Reaction times were log-transformed to exclude any data-points corresponding to participants responding extremely fast or slow, and to prepare the data for a mixed model analysis. As for Study 1, outliers were identified using the interquartile range criterion. The median reaction times for each condition are reported in Table 16. The results revealed no clear contrast in response time between conditions. This was confirmed by the absence of any statistical effect in a mixed effect model. Using the *lmer* function from the *lme4* package (Bates et al., 2015), the log-transformed reaction times were regressed against the number of disjunct true, the type of prosody and the interaction between the two. None of the coefficients of the model, reported in Table 17, were significant. In other words, participants answered at the same speed regardless of the prosody.

Group	Condition	Median	IQR
OR Prosody	No Disjunct True	516	510
	One Disjunct True	629	647
NEG Prosody	No Disjunct True	625	983
	One Disjunct True	731	954

Table 16: Median reaction times and IQR per condition after outlier exclusion for each condition. Log-transformed values were back-transformed into milliseconds for readability.

Predictor	Estimate (β)	SE	z	p
Intercept	6.46	0.10	64.90	$< .001^{***}$
One Disjunct True	0.12	0.09	1.41	.169
OR Prosody	−0.11	0.13	−0.89	.376
One Disjunct True × OR Prosody	−0.03	0.09	−0.37	.713

Table 17: Coefficients of the model regressing the log-transformed reaction times against the interaction of the prosody type and the number of disjuncts true. Formula: *log(RT)* ~ *nb_of_disjuncts_true * prosody_type + (1 | participants) + (1 | items)*

6 General discussion

The goal of this study was twofold: first, to investigate whether French disjunction is truly a positive polarity item (PPI); second, to determine whether prosody can serve as a disambiguating factor between the available interpretations of negated disjunction.

Negated disjunctive statements are logically ambiguous. Yet, many studies have shown that speakers tend to have a preference for either the *exclusive* interpretation (i.e. exactly one of the two disjuncts is true), or the *neither...nor* interpretation (i.e. neither of the two disjuncts is true). Szabolcsi (2002) analysed this preference as a consequence of a cross-linguistic parameter, arguing that disjunction is a positive polarity item in languages like French, Japanese, Hungarian or Italian. A positive polarity disjunction enjoins speakers of the aforementioned languages to interpret disjunction outside of the scope of negation (see Section 2). However, recent experimental studies on French (Cochard et al., 2023; Lungu et al., 2021; Larralde et al., 2021; Becerra Zita et al., 2014) challenge this claim, showing that the *neither...nor* interpretation is accessible under the right conditions. These previous findings as well as the results from this study are problematic for an analysis of French disjunction *ou* "ou" in terms of positive polarity item.

The discussion is organised as follows, Section 6.1 summarises the main findings, showing that prosody is a disambiguating factor. Section 6.2 reconsiders Szabolcsi's (2002) positive polarity parameter by proposing two alternatives to explain the variation attested in French speakers. Finally, Section 6.3 discusses the consequences of our findings for acquisition.

6.1 Prosody is a disambiguating factor

Developing the long-standing idea that prosody plays a role in disambiguating the scope interaction between logical operators (Bolinger, 1965; Jackendoff, 1972; Syrett et al., 2014; Kadmon & Roberts, 1986; Ladd, 1980; Ward & Hirschberg, 1985; Pruitt & Roelofsen, 2013; Larralde et al., 2021; Surányi & Gulás, 2022; van Hout et al., 2024; among many others), we conducted two experiments to determine whether a specific interpretation is systematically associated with a particular prosodic contour (Study 1), and whether a specific prosodic contour actively drives listeners towards one reading or another (Study 2). We investigated this issue in French, a language for which it has been assumed that disjunction scopes above negation (Spector, 2014; Nicolae, 2017; Pagliarini et al., 2022). This assumption did not match our own intuitions, and, moreover, has been experimentally shown to be incorrect, both in adults (Cochard et al., 2023; Lungu et al., 2021; see also Chapter 3) and in children (Cochard et al., 2023; Larralde et al., 2021; see also Chapter 3). The main goal of the two studies presented in this chapter was to determine the extent to which both interpretations are accessible in French, and, more specifically, whether one or the other would preferentially arise for a particular prosodic contour. Ultimately, the findings from both studies should clarify whether French disjunction truly behaves as a positive polarity item.

Study 1 investigated whether the *exclusive* and the *neither...nor* interpretations are associated with distinct prosodic contours. In the experiment, participants were presented with a prosody selection task: after reading a disambiguating story, they were asked to choose between two audio recordings of the same disjunctive sentence, each differing only in prosodic contour. One contour was designed to match the *exclusive* interpretation, and the other the *neither...nor* interpretation, following the prosodic manipulations used in Surányi and Gulás (2022) and van Hout et al. (2024). The results revealed that participants preferred the prosody matching the interpretation cued by the story. Specifically, in *exclusive* stories, participants selected the *OR Prosody* 76% of the time. Conversely, in *neither...nor* stories, they selected the *NEG Prosody*

85% of the time. These findings suggest a systematic mapping between prosodic contour and interpretation. A small subgroup of participants, potentially reflecting chance-level behaviour, showed a consistent preference for the *NEG Prosody* regardless of the type of the story.[18]

The fact that the preference for specific prosodic contours aligned with interpretation in Study 1 justified the use of these contours in Study 2, which aimed to test the reverse relation: whether prosody can drive participants towards one interpretation. In a truth-value judgement task, participants judged whether the audio recording of a disjunctive statement was an appropriate description of a situation in which both, one or neither of two disjuncts were true. The design was between-subjects: one group heard only the *OR Prosody*, and the other only the *NEG Prosody*. The results showed that prosody influenced interpretation. Among those who heard the *OR Prosody*, about half adopted the *exclusive* reading; the remaining participants offered either a *neither...nor* or a *not both* interpretation. Participants who heard the *NEG Prosody* showed the opposite trend: about half favoured the *neither...nor* interpretation, while the rest divided between *exclusive* and *not both* readings. This individual variation suggests that prosody shapes interpretation for some participants, while others seem to exhibit more stable preferences, regardless of our prosodic manipulations.

Taken together, the findings from Study 1 and Study 2 lead to two key insights. First, prosody is a disambiguating factor that shapes the interpretation of negated disjunctive statements. Second, this effect of prosody did not hold across the board for all speakers. In Study 2, in particular, some participants consistently adopted interpretations that did not align with the prosodic contour they heard. This suggests that some participants may have shown a stable preference that holds regardless of the prosodic manipulation. However, given the between-subjects design, we cannot firmly conclude that these speakers were oblivious to prosody. Nonetheless, the overall results undermine the claim that French disjunction behaves as a strict positive polarity item, since *neither...nor* readings are readily available in our experiment.

Overall, the results further suggest that French speakers may fall into two main interpretive profiles, as summarised below in (51).

(51) a. **Group 1:** Mapping between interpretation and prosody.
b. **Group 2:** Preference for an interpretation regardless of prosody.

The first group includes participants who, in Study 1, matched each interpretation with a specific prosodic contour, and in Study 2, allowed prosodic contours to guide their interpretation. For these speakers, prosody clearly plays a decisive role in the interpretation of negated disjunctive statements.

The second group consists of participants who show a stable preference for a single interpretation in Study 2, irrespective of the prosodic contour. This does not mean that these speakers are entirely oblivious to prosody or answered randomly in Study 1, but rather that, when only one prosodic contour is presented, they choose to commit to their preferred interpretation (either *exclusive* or *neither...nor*). To determine whether there really are speakers who are insensitive to prosody in negated disjunctive statements, a within-subject version of

[18] But we can only speculate on why these participants consistently preferred the *NEG Prosody* contour. One possibility is that this prosody simply felt more natural, or that the *OR Prosody* was perceived less natural than the *NEG Prosody*. Another possibility is that most stories concluded with a negative outcome (e.g., not approving an activity, failing to follow the doctor's recommendation), rather than a positive one (e.g., successfully avoiding a mistake), and such outcome might be better captured by a prosodic contour that emphasizes negation.

Study 2, where participants hear both prosodic contours, should be conducted. If speakers from this second group maintain their preferred interpretation across different prosodic contours, this would provide evidence that these participants are in fact oblivious to prosody.

Note that in addition to those participants showing a clear preference for either the *exclusive* or the *neither...nor* interpretation, some participants displayed a *not both* interpretation in Study 2. These participants interpreted disjunction above the scope of negation but did not calculate the exclusivity inference. The question remains, however, whether prosody was really a disambiguating factor for these participants who accepted both the *No Disjunct True* and the *One Disjunct True* conditions. One possibility is that these participants simply preferred this interpretation, considering that a negated disjunctive statement is an appropriate utterance to describe both a *No Disjunct True* and a *One Disjunct True* scenario. Another possibility is that they were only weakly inclined toward the *exclusive* or the *neither...nor* interpretation and defaulted to the *not both* interpretation, which is compatible with every relevant situation, when they heard a prosodic contour that did not align with their preferred interpretation. For instance, upon hearing a negated disjunctive statement with prosodic stress on disjunction (i.e., the *OR Prosody*), a speaker with a weak preference for the *neither...nor* interpretation may be more inclined to accept the *One Disjunct True* condition, without committing to reject the *No Disjunct True* condition. Conversely, upon hearing a disjunctive statement with prosodic stress on negation (i.e., the *NEG Prosody*), a speaker with a weak preference for the *exclusive* interpretation might find the *No Disjunct True* condition acceptable, without committing to reject the *One Disjunct True* condition.

6.2 Reconsidering the positive polarity parameter

The findings presented above challenge the alleged positive polarity status of French disjunction *ou* "or". Contrary to Spector (2014), Nicolae (2017) and Pagliarini et al. (2022), who assumed that French disjunction is a positive polarity item (PPI), the results of the current studies show that French speakers can access the supposedly unavailable *neither...nor* interpretation. In this section, we propose two alternative explanations to account for this behaviour in French, one treats scope semantically, preserving Szabolcsi's (2002) cross-linguistic parameter, while the other one treats scope syntactically.

First, we propose that the cross-linguistic positive polarity parameter operates at an individual level. That is, for some French speakers, *ou* is treated as a PPI, while for others it is not. For speakers who treat disjunction as a PPI, only the *not both* and the *exclusive* interpretations should be available (depending on whether the exclusivity inference has been calculated). For the other speakers, disjunction is not a PPI and is thereby free to scope above or below negation, allowing the *exclusive*, the *not both*, and the *neither...nor* interpretations to arise. Importantly, speakers who do not treat French disjunction *ou* as a PPI may still have a preference for one reading over the others, while not critically disallowing the alternative interpretations, although this preference may vary across individuals. Crucially, this proposal also explains why roughly two-thirds of the participants interpreted disjunction above negation, while the remaining one-third interpreted it below. Since there is only one group of speakers who allow the *neither...nor* reading (-PPI speakers) but two groups who allow the *exclusive* and *not both* readings (+PPI and -PPI speakers), the prevalence of the latter two interpretations in the tested French population was expected to be higher.

Second, we suggest a concurrent account in which the interpretation of negated disjunctive statements is driven by their underlying syntactic structure, rather than by a semantic parameter. To illustrate, consider the conjunctive statement in (52), which is syntactically ambiguous

between a phrasal structure (52a; coordinating two smaller phrases) and a clausal structure (52b; coordinating clauses with elided content in the second clause). Suppose there are forms that are either big or small, and either red or blue. Under a phrasal structure, one is expected to circle only the forms that are both red and small. To the contrary, under a clausal structure, one is expected to circle every form except those that are both blue and big.

(52) Circle the forms that are red and small.
   a. Circle the forms that are [red and small]. Phrasal
   b. [Circle the forms that are red] and [circle the forms that are small]. Clausal

This distinction between phrasal and clausal syntactic structures is critical for the interpretation of statements with logical connectives, in particular in negated disjunctive statements. Consider (53) as an illustration. Under a phrasal structure, the negated disjunctive statement naturally receives a *neither...nor* interpretation. Disjunction is syntactically scoping under negation and gives rise to the *neither...nor* reading as per De Morgan's laws. By contrast, under a clausal structure, the sentence is expected to receive an *exclusive* interpretation due to disjunction being structurally outside of the scope of negation.

(53) Liz does not like mathematics or geography.
   a. Liz does not like [mathematics or geography]. Phrasal
   b. [Liz does not like mathematics] or [Liz does not like geography]. Clausal

We speculate that French negated disjunctive statements may be ambiguous between a phrasal and a clausal syntactic structure.[19] This would explain why some speakers access the *exclusive* reading while others derive the *neither...nor* reading. This proposal would also align with findings showing that prosody can reflect the underlying syntactic structure (Snedeker & Trueswell, 2003; Delais-Roussarie et al., 2011; Selkirk, 2011; Delais-Roussarie et al., 2020). Hence, the prosodic manipulations in the *OR Prosody* and *NEG Prosody* conditions may have influenced participants' syntactic parsing of disjunctive statements.

In sum, we have proposed two possible accounts of the observed variation in French: one that preserves the positive polarity status of disjunction and one that models the speakers' variation through syntax. Although the latter proposal seems promising in explaining the variation attested in French, it needs to be developed and investigated in a separate study that we leave for future research.

6.3 Consequences for acquisition

In this final section, we consider the consequences of our findings for language acquisition, particularly in light of evidence that French allows both the *neither...nor* and the *exclusive* interpretations, and that prosody contributes to distinguishing between them.

Acquisition studies consistently treated the *neither...nor* reading as non-adult-like in +PPI languages (Goro, 2007; Goro & Akiba, 2004; Geçkin et al., 2018; Cochard et al., 2023; Pagliarini et al., 2022; among others), including French, based on the assumption that children follow the Semantic Subset Principle (Crain et al., 1994; Crain, 2012; Moscati & Crain, 2014). This principle states that when confronted with a logically ambiguous sentence, children initially favour the interpretation that is true in the narrowest range of circumstances (see also Chapter 3 for details and discussion about this principle). However, since we have now shown

[19] See also Hiraiwa and Nakanishi (2025) who proposes that Japanese disjunction *ka* is not a PPI and that the *exclusive* interpretation arises because Japanese disjunctive statements have the underlying syntax of an alternative question in which two complementizer clauses are conjoined (e.g. "whether it is P or it is Q").

that the *neither...nor* interpretation is in fact a valid adult-like option in French, the conclusions drawn in earlier acquisition studies must be reconsidered. Importantly, once both interpretations are acknowledged as adult-like, it becomes impossible to confidently label French children showing a *neither...nor* reading as (non-)adult-like.[20] Moreover, as demonstrated in Chapter 3, *neither...nor* responses can stem from three distinct sources: (i) disjunction taking narrow scope under negation due to a genuine preference for this scope configuration; (ii) a preference for resolving as much ignorance as possible; (iii) or a non-adult-like strengthening of a wide-scope disjunction.

Second, the finding that (some) adults are sensitive to prosody in negated disjunctive statements raises the question of the role of prosody in the interpretation of disjunction. As is well known, prosodic focus can activates alternatives (Rooth, 1985, 1992; Krifka, 2008; among others) and, in particular, focus on the disjunctive connective can activate the alternatives to disjunction, thereby facilitating the derivation of scalar implicatures (Fox & Katzir, 2011; Chierchia et al., 2011). In parallel, children are known to struggle with the generation of specific alternatives, often resulting in non-adult-like interpretations of disjunctive statements (Singh et al., 2016; Tieu et al., 2017; see also Chapters 3 and 5). However, it is plausible that prosody may assist in generating the required alternative (i.e. the conjunctive alternative *and*) to arrive at an adult-like interpretation. Yet, the acquisition of prosodically marked disjunction remains a largely unexplored domain. Moreover, the limited empirical evidence presents a mixed picture: while two studies report that prosodic cues play a role in the emergence of the *exclusive* interpretation (Jasbi et al., 2018, 2022), another study finds no such effect (Bleotu et al., 2024a).

7 Concluding remarks

This chapter examined the question of how French disjunction behaves under negation, with a particular focus on whether *ou* "or" truly behaves as a positive polarity item (PPI), and whether prosody can serve as a disambiguating cue between the possible readings of negated disjunctive statements. Although French has traditionally been classified as a language in which disjunction scopes above negation (+PPI; Spector 2014; Nicolae 2017), yielding only *exclusive* (or *not both*) readings, the present findings challenge this categorical view by showing that *neither...nor* readings are also readily available, corroborating recent studies on French (Cochard et al., 2023; Larralde et al., 2021; Lungu et al., 2021; see also Chapter 3).

Across two experiments, we found converging evidence that prosody functions as a disambiguating factor for French speakers. Study 1 revealed a systematic association between interpretation and prosodic contour: participants preferred a contour carrying a rising pitch before the disjunctive connective in contexts supporting the *exclusive* interpretation, and a contour carrying a rising pitch on negation in contexts supporting the *neither...nor* interpretation. Study 2 showed that prosody can actively bias interpretation, though not uniformly: whereas some speakers aligned their interpretation with the prosodic contour they were assigned, others maintained a stable interpretive preference regardless of prosodic manipulation.

Taken together, these results indicate that prosody can shape the interpretation of negated disjunction in French, although there was individual variation. This variation strongly suggests the coexistence of distinct groups among French speakers. One group consistently maps interpretation onto prosody and a second group shows a stable preference for a single interpretation, either *exclusive* or *neither...nor*.

[20] However, see Chapter 3 in which we show that we can use the performance on simple disjunctive statements to identify *neither...nor* readings arising for non-adult-like reasons.

The implications of our studies are twofold. First, the variation attested in French is problematic for an analysis in terms of Szabolcsi's (2002) PPI parameter. Instead, we propose refining the parameter, suggesting that it also operates at the individual level, between speakers. We furthermore propose that the attested variation can also be explained in light of the underlying syntactic structure, which may be informed by prosody. Second, at the acquisition level, our results impact the interpretation of the results of previous studies examining the development of negated disjunction (e.g., Pagliarini et al. 2022, who examined French children). In these studies *neither...nor* readings have been systematically coded as non-adult-like in +PPI languages. However, since this interpretation is also available for adults, it can no longer be considered inherently non-adult-like (at least for French).

Several questions remain to be addressed in future research. One important direction concerns the generalisability of these findings across languages: do the same interpretive profiles arise in other alleged +PPI languages (e.g., Italian, Catalan, Hungarian, Japanese)? Finally, a natural next step is to assess whether children are similarly sensitive to prosodic cues in disjunction, a question we leave open for future investigation.

Chapter 5

The acquisition of modal disjunctive statements: Disentangling free choice from modal conjunction

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1 Introduction

Simple disjunctive statements[1] as in (1) typically yield the inference that exactly one of the two disjuncts is true; this is the exclusivity inference, paraphrased in (1a) and generated by strengthening the logical, inclusive, meaning of disjunction. Several acquisition studies have reported that children between four and five years old show non-adult-like performance with such statements in a wide range of languages such as English, Italian, French, Japanese, Romanian, and many others. These children either do not generate the exclusivity inference and allow the *inclusive* meaning of disjunction (1b; Boster and Crain 1993; Chierchia et al. 2001b, 2001a; Singh et al. 2016; Tieu et al. 2017; Cochard et al. 2023; Sauerland and Yatsushiro 2018; Pagliarini et al. 2018a; Goro et al. 2006; Huang and Crain 2020; Su 2014; Su and Crain 2010; Bleotu et al. 2023), or they derive an incorrect *conjunctive* reading, assigning the truth-conditions of conjunction to disjunction (2; Braine and Rumain 1981; Paris 1973; Singh et al. 2016; Tieu et al. 2017; Cochard et al. 2023; Bleotu et al. 2023; Lobina et al. 2023a).

(1) Liz bought a croissant or a donut.
   a. **Exclusivity inference:**
      $\rightsquigarrow$ Liz bought a croissant or a donut, but not both. $\neg(P \wedge Q)$
   b. **Logical meaning:**
      Liz bought a croissant or a donut, possibly both. $(P \vee Q)$

(2) $\rightsquigarrow$ Liz bought a croissant and a donut.

But the *conjunctive* reading is not limited to child language and is also naturally found in the adult one, specifically in modal disjunctive statements. When disjunction is embedded under a possibility modal[2] as in (3), the conjunction of two modal disjuncts (3b) is typically inferred, i.e. both disjuncts must each be individually permitted. Hence, (3) is taken to mean that there are two pastries that Liz has the possibility to buy, the croissant and the donut. That is, Liz is free to buy whichever pastry she chooses. This interpretation, which does not result from a mere semantic entailment, has been taken to be an inference, traditionally referred to as a free choice inference (Kamp, 1974). Furthermore, in addition to the free choice inference, an additional, though optional (Liu, 2017; Simons, 2005), exclusivity inference can be generated, according to which it is not possible for Liz to buy the croissant and the donut together (3c).

(3) Liz can buy a croissant or a donut.
   a. **Logical meaning:**
      Liz can buy a croissant or a donut, possibly both. $\Diamond(P \vee Q)$
   b. **Free Choice inference:**
      $\rightsquigarrow$ Liz can buy a croissant and Liz can buy a donut. $\Diamond P \wedge \Diamond Q$
   c. **Exclusivity inference:**
      $\rightsquigarrow$ Liz cannot buy both a croissant and a donut. $\neg\Diamond(P \wedge Q)$

It has been shown experimentally that free choice inferences are readily accessible and processed. For instance, Chemla and Bott (2014) demonstrated that such inference required

[1] Disjunctive statements which are not embedded under another operator, such as negation or a modal, are referred to as simple disjunctive statements in this dissertation.

[2] For consistency throughout this chapter, can is taken to express root circumstantial possibility (e.g., it is possible for Liz to buy pastries given the actual facts of the situation), and not general ability (e.g., Liz has a special skill to buy pastries) or epistemic possibility (e.g., at the moment, Liz might be buying pastries) (Hacquard, 2011; Kratzer, 1991).

less processing time than regular scalar implicatures, and several acquisition studies also found that children correctly derive this inference at adult-like rates (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020).[3]

The contribution of this chapter is twofold. After introducing the derivation of the free choice inference in Section 2, based on the grammatical approach to scalar implicatures (Alonso-Ovalle, 2006; Fox, 2007; Chierchia et al., 2011; Bar-Lev & Fox, 2020; Klinedinst, 2007; Chemla, 2009b; Van Rooij, 2010; Franke, 2011; Kratzer & Shimoyama, 2002), we argue in Section 3 that children may not show a genuine free choice inference in the aforementioned studies, but instead a *Modal Conjunctive* interpretation taking the form of a conjunctive statement embedded under a modal ($\Diamond[P \wedge Q]$). In previous designs, the critical condition where only one of the two disjuncts was true could not tease apart a free choice interpretation from a *Modal Conjunctive* one, since both interpretations have exactly the same falsifying and verifying conditions for that condition. To investigate children's interpretation in more depth, we developed an experimental design that specifically aimed to disentangle the free choice interpretation and *Modal Conjunctive* interpretation by introducing two new conditions: a *Mutually Exclusive* scenario that targeted the *Modal Conjunctive* interpretation, and a *Package* scenario for the additional exclusivity inference.

The results showed that a subset of children did not compute any inference while another subset of alleged adult-like children were in fact *Modal Conjunctive* interpreters. Second, this chapter offers an account for the *Modal Conjunctive* interpreters based on a non-adult-like pragmatic enrichment procedure as initially proposed by Singh et al. (2016) for the *conjunctive* interpretation of disjunction in simple contexts and embedded under a universal quantifier like *every*. In particular, we show how each of the attested patterns can be explained by the interaction between the nature of the set of alternatives under consideration and, moreover, the locus of pragmatic enrichment. We argue that the *Modal Conjunctive* interpretation arises when the conjunctive alternative is absent from the set of alternatives and that pragmatic enrichment occurs locally, between the modal and the disjunctive statement. This makes the strengthening process in a subset of learners exactly parallel to the *conjunctive* strengthening of simple disjunction to the meaning of conjunction, thus offering a unified account for children's non-target-like interpretation of disjunction in modal sentences as well as in simple sentences.

The chapter is structured as follows: first, Section 2 describes how the free choice inference arises in the adult grammar using the grammatical approach to scalar implicatures (i.e. throughout an exhaustification procedure). This will be used as the framework for explaining children's non-adult-like readings in the Discussion section. Then, in Section 3, we detail how previous studies could not identify the *Modal Conjunctive* interpretation or the exclusivity inference. In Section 4, we present the rationale of our experiment and in Section 5 the method and design. The results are reported in Section 6. In Section 7, we discuss our findings and propose an exhaustification approach to account for the four attested interpretive patterns in children in this study. Finally, Section 8 concludes the chapter.

[3] Tieu et al. (2016) showed that children can also derive free choice inferences in sentences where *any* has been embedded under a possibility modal, as in (i).

(i) Liz can buy any pastry.
   a. $\rightsquigarrow$ Liz can buy a croissant.
   b. $\rightsquigarrow$ Liz can buy a donut.
   c. $\rightsquigarrow$ Liz can buy a chocolate bread.
   d. $\rightsquigarrow$ ...

2 Deriving the free choice interpretation in the exhaustification framework

A major challenge in accounting for free choice effects is that they do not follow from the interaction of the classic semantics for possibility modals and boolean disjunction. Since Kamp (1974), this observation has spurred considerable interest in the literature, leading to the development of several accounts to explain how free choice effects arise. Several competing lines of reasoning have been proposed: some authors argued that the free choice inference is the consequence of a semantic entailment derived from non-standard logical operations (Aloni, 2007, 2016, 2022; Barker, 2010; Goldstein, 2019; Simons, 2005) or from a different logical transcription of linguistic disjunction (Zimmermann, 2000; Geurts, 2005). Conversely, other scholars have claimed that the free choice inference arises from standard logical operations as an implicature,[4] either via the classic conversational approach (Gazdar, 1979; Schulz, 2006; Spector, 2006; van Rooij & Schulz, 2004) or through a grammatical approach where free choice results from the (possibly recursive) application of an exhaustification operator (*Exh*) (Fox, 2007; Chierchia et al., 2011; Chemla, 2009b; Bar-Lev, 2018; Bar-Lev & Fox, 2020).[5]

For this chapter, we adopted the grammatical approach for two reasons: first, previous acquisition studies have framed children's conjunctive interpretation for disjunction in simple sentences within this approach (Tieu et al., 2017; Singh et al., 2016). Second, we extend prior non-adult-like grammatical accounts and introduce a further component that crucially participate in the explanation of the *Modal Conjunctive* interpretation, namely, the locus of the pragmatic enrichment mechanism. In Section 2.1, we present the core part of the exhaustification procedure while in Section 2.2 we provide the derivation of the free choice inference in this framework.

2.1 The exhaustification procedure

The core part of the grammatical approach to scalar implicatures relies on the insertion, at the syntactic level, of an exhaustification operator *Exh* (Fox, 2007). As an illustration, take a sentence S to which *Exh* has been appended, (4). Here, the main purpose of the *Exh* operator is to return a sentence whose meaning has been strengthened after all relevant alternatives of S have been negated. The resulting enriched interpretation is henceforth referred to as S^+, where the superscript plus denotes the strengthened meaning.

(4) $Exh(ALT(S))(S) \Leftrightarrow S^+$

[4] One argument supporting the implicature approach is the behaviour of modal disjunctive statements embedded under negation. For instance, Alonso-Ovalle (2005), following Kratzer and Shimoyama (2002), argues that the free choice inference should be treated as an implicature on the basis of its disappearance under negation as in (i).

(i) You are not allowed to eat the cake or the ice-cream. $\neg\Diamond(P \vee Q)$
   a. $\rightsquigarrow$ It is not allowed to eat the cake and it is not allowed to eat the ice-cream. $\neg(\Diamond P) \wedge \neg(\Diamond Q)$
   b. $\neq$ It is not the case that you are allowed to eat the cake and you are allowed to eat the ice-cream. $\neg(\Diamond P \wedge \Diamond D)$

The sentence in (i) can only mean that it is not allowed to eat either of the two desserts, an interpretation also known as dual prohibition. It cannot mean that the possibility to choose either of the two desserts (i.e., free choice) is negated. For an acquisition study on dual prohibition, see Tieu et al. (2024), whose results appear to support an homogeneity approach of free choice (Goldstein, 2019).

[5] Some grammatical approaches derive free choice inferences without positing an *Exh* operator (Kratzer & Shimoyama, 2002; Van Rooij, 2010; Klinedinst, 2007; Alonso-Ovalle, 2005, 2006). In addition, other accounts explain free choice through rational or probabilistic models of communication, such as game-theoretic or RSA frameworks (Franke, 2011).

The denotation of *Exh*, given in (5) below, reads as follows: *Exh* takes a prejacent p (i.e. the basic logical meaning of S), and the set of alternatives of S, $ALT(p)$. Then, *Exh* asserts the prejacent and negates all innocently excludable alternatives, namely, alternatives which can be excluded consistently with the prejacent. The set of innocently excludable alternatives is defined by the innocent exclusion function given in (6), which consists of the intersection of every maximal subset whose alternatives can be negated while preserving consistency with the prejacent.

(5) **Exhaustivity operator:** (Fox, 2007)
$[\![Exh]\!](ALT)(p)(w) \Leftrightarrow (p)(w) \wedge \forall q \in \mathrm{IE}(p, ALT)[\neg q(w)]$

(6) **Innocent Exclusion function:** (Fox, 2007)
$\mathrm{IE}(p, ALT) = \cap(ALT' \subseteq ALT : ALT'$ is a maximal subset of ALT,
such that $\{\neg q : q \in ALT'(p)\} \cup \{p\}$ is consistent)

Take a simple disjunctive statement $(P \vee Q)$ whose set of alternatives in (7) is generated by applying the algorithm in (8) (Sauerland, 2004; Katzir, 2007). Then apply the innocent exclusion function to this set: the two maximal subsets of $(P \vee Q)$ in (9) only have one alternative in common, the scalar alternative $(P \wedge Q)$, (10). The resulting set is referred to as the set of innocently excludable alternatives ALT^{IE}.

(7) **Set of alternatives for $(P \vee Q)$:**
$ALT(P \vee Q) = \{\underbrace{(P \vee Q)}_{\text{Prejacent}}, \underbrace{P}_{\text{Individual disjuncts}}, \underbrace{Q}_{\text{Individual disjuncts}}, \underbrace{(P \wedge Q)}_{\text{Conjunctive alternative}}\}$

(8) **Algorithm to generate the set of alternatives of $(P \vee Q)$:** (Katzir, 2007)
a. Take the prejacent: $(P \vee Q)$ — Prejacent
b. Take sub-constituents: P and Q — Individual disjuncts
c. Lexical replacement: $(P \wedge Q)$ — Conjunctive alternative

(9) **Maximal subsets of $(P \vee Q)$:**
a. $\{P, (P \wedge Q)\}$
b. $\{Q, (P \wedge Q)\}$

(10) **Set of Innocently Excludable alternatives of $(P \vee Q)$:**
$ALT^{\mathrm{IE}}(P \vee Q) = \{P, (P \wedge Q)\} \cap \{Q, (P \wedge Q)\}$
$= \{(P \wedge Q)\}$

Appending *Exh* to $(P \vee Q)$ leads to the exclusion of every alternative located in the set of innocently excludable alternative of $(P \vee Q)$. Here, the scalar alternative is the only one to be negated, and as a result, the exclusivity inference of simple disjunction is successfully derived, as shown with the derivation in (11).

(11) $Exh(ALT(P \vee Q))(P \vee Q) \Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\mathrm{IE}}(P \vee Q))}_{\text{Negating IE Alternatives}}$
$\Leftrightarrow \underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(P \wedge Q)}_{\text{Exclusivity}}$

Notice that the *Exh* operator does not apply blindly. Fox (2007) defined the licensing condition in (12) based on formerly derived ignorance inferences.[6] Specifically, whenever a sentence S generates ignorance inferences, that is the speaker is unsure about the truth of at least one of the alternatives, the *Exh* operator is applied to S in order to resolve as much ignorance as possible.

(12) ***Exh* parsing strategy:** (Fox, 2007)
If a sentence S has an undesirable Ignorance Inference, parse it as $Exh(ALT(S))(S)$.

Here, ignorance refers to a state of belief where the speaker does not know whether a statement is true or not. For instance, prior to any pragmatic enrichment, a disjunctive statement yields the ignorance inferences such as in (13), which triggers the *Exh* parsing strategy. After exhaustification has been applied, some ignorance has been resolved as the speaker no longer ignores whether Liz bought a croissant and a donut. But, she remains ignorant about whether Liz bought the croissant and whether Liz bought the donut.

(13) **Ignorance inferences for *Liz bought a croissant or a donut*:**
a. $\rightsquigarrow$ The speaker ignores whether Liz bought a croissant.
b. $\rightsquigarrow$ The speaker ignores whether Liz bought a donut.
c. $\rightsquigarrow$ The speaker ignores whether Liz bought a croissant and a donut.

Importantly, if the strengthened sentence (S^+) resulting from the first round of exhaustification still carries ignorance (e.g. (13a) and (13b) for simple disjunction), then S^+ becomes a legitimate candidate for a second round of exhaustification. However, in the case of simple disjunction, adults typically do not proceed beyond the first round. As we demonstrate in the next section, a second round of exhaustification is necessary within Fox's framework to derive free choice inferences, but it would result in a contradiction in the case of simple disjunction.

2.2 Deriving the free choice inference in the adult grammar

Now, let us turn to modal disjunctive statements. Since there is uncertainty about the scalar alternative and the individual disjuncts, the exhaustification procedure is licensed. The composition of the set of alternatives under consideration for modal disjunction is fully parallel to the set of alternatives for simple disjunction. This set includes the prejacent, the individual disjuncts, and the scalar alternative, as illustrated in (14).[7] As a result, the set of innocently excludable alternatives includes only the alternative common to both maximal subsets (15), namely the scalar alternative, modal conjunction (16; $\Diamond[P \wedge Q]$).

(14) **Set of alternatives for $\Diamond(P \vee Q)$:**
$$ALT(\Diamond[P \vee Q]) = \{\underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}}, \underbrace{\Diamond P, \Diamond Q}_{\substack{\text{Individual}\\ \text{disjuncts}}}, \underbrace{\Diamond(P \wedge Q)}_{\substack{\text{Conjunctive}\\ \text{alternative}}}\}$$

[6] See Chapter 2 for the derivation of ignorance inferences as conversational implicatures.

[7] In fact, the set given in (14) is not complete as it does not include the alternatives generated from the lexical replacement of the possibility modal $\Diamond$ by the necessity modal $\Box$. The complete set is given below in (i):

(i) $ALT(\Diamond(P \vee Q)) \Leftrightarrow \Diamond(P \vee Q), \Diamond P, \Diamond Q, \Diamond(P \wedge Q), \Box(P \vee Q), \Box P, \Box Q, \Box(P \wedge Q)$

However, to avoid clutter in the formulas, we decided to not include the necessity alternatives. Furthermore, their inclusion does not change the output result and Bar-Lev and Fox (2020) pointed out that it is not even sure that these alternatives should be generated to begin with.

(15) **Maximal subsets of $\Diamond(P \vee Q)$:**
a. $\{\Diamond P, \Diamond(P \wedge Q)\}$
b. $\{\Diamond Q, \Diamond(P \wedge Q)\}$

(16) **Set of Innocently Excludable alternatives of $\Diamond(P \vee Q)$:**
$ALT^{\text{IE}}(\Diamond[P \vee Q]) = \{\Diamond P, \Diamond(P \wedge Q)\} \cap \{\Diamond Q, \Diamond(P \wedge Q)\}$
$= \{\Diamond(P \wedge Q)\}$

However, the first round of exhaustification of a modal disjunctive statement yields a meaning that is actually weaker than the targeted free choice interpretation, as illustrated below in (17). The output formula in (17) can be paraphrased as follows: the speaker is open to the possibility that P, the speaker is open to the possibility that Q, and the speaker is sure that the possibility that both P and Q together does not hold ($\neg\Diamond[P \wedge Q]$). In other words, the speaker is still unsure about whether P is possible and Q is possible, indicating that some ignorance still needs to be resolved. Now, for a free choice interpretation to be derived, the speaker must know that P is possible and Q is possible ($\Diamond P \wedge \Diamond Q$), that is ignorance about P and Q has to be resolved. In sum, the first round of exhaustification only delivers an exclusivity inference; the free choice inference is yet to be derived.

(17) $Exh(ALT(\Diamond[P \vee Q]))(\Diamond[P \vee Q]) \Leftrightarrow \underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg ALT^{\text{IE}}(\Diamond[P \vee Q])}_{\text{Negating IE Alternatives}}$
$\Leftrightarrow \underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg\Diamond(P \wedge Q)}_{\text{Exclusivity}}$

But, since there is still ignorance to be cleared about the individual disjuncts, P and Q, a second round of exhaustification is triggered by the the *Exh* parsing strategy. Notice that, since the statement to which *Exh* is appended has already been strengthened, each member of the base set of alternatives has also been strengthened, resulting in the set in (18).[8] For readability, the output formula of the first round of exhaustification, $\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)$, has been abbreviated as $Exh(\Diamond[P \vee Q])$ in (18) to (20).

(18) **Set of alternatives for $Exh(\Diamond[P \vee Q])$:**
$ALT(Exh(\Diamond[P \vee Q]))$
$= \{\underbrace{Exh(\Diamond[P \vee Q])}_{\text{Prejacent}}, \underbrace{Exh(\Diamond P), Exh(\Diamond Q)}_{\text{Individual disjuncts}}, \underbrace{Exh(\Diamond[P \wedge Q])}_{\text{Conjunctive alternative}}\}$
$= \{\underbrace{\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)}_{\text{Prejacent}}, \underbrace{(\Diamond P \wedge \neg\Diamond Q), (\Diamond Q \wedge \neg\Diamond P)}_{\text{Individual disjuncts}}, \underbrace{\Diamond(P \wedge Q)}_{\text{Conjunctive alternative}}\}$

The only maximal subset that can be excluded without generating a contradiction with the prejacent consists of the two individual disjuncts: $\Diamond P \wedge \neg\Diamond Q$ and $\Diamond Q \wedge \neg\Diamond P$, (19). These

[8] The set of exhaustified alternatives is obtained by enriching each base alternative with regards to the set of alternatives of disjunction as in (i).

(i) a. $Exh(\Diamond(P \vee Q))(\Diamond(P \vee Q)) \Leftrightarrow \Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)$
b. $Exh\Diamond(P \vee Q))(\Diamond P) \Leftrightarrow \Diamond P \wedge \neg\Diamond Q$
c. $Exh(\Diamond(P \vee Q))(\Diamond Q) \Leftrightarrow \Diamond Q \wedge \neg\Diamond P$
d. $Exh(\Diamond(P \vee Q))(\Diamond(P \wedge Q)) \Leftrightarrow \Diamond(P \wedge Q)$

two individual disjuncts are then negated which, finally, yields the free choice inference, as demonstrated in the derivation in (20).

(19) **Set of Innocently Excludable alternatives of** $Exh(\Diamond[P \vee Q])$**:**
$ALT^{\text{IE}}(Exh(\Diamond[P \vee Q])) = \{(\Diamond P \wedge \neg\Diamond Q),\ (\Diamond Q \wedge \neg\Diamond P)\}$

The output formula reads as follows: the speaker is sure that P is possible that Q is possible (the free choice inference; $\Diamond P \wedge \Diamond Q$), and moreover she is sure that it is not possible to have P and Q conjointly (the exclusivity inference; $\neg\Diamond[P \wedge Q]$). As there is no longer any ignorance to resolve, the exhaustification procedure halts. In sum, a second round of pragmatic enrichment successfully derives the free choice interpretation.

(20) $Exh(ALT(Exh(\Diamond[P \vee Q])))(Exh(\Diamond[P \vee Q]))$

$$\Leftrightarrow \underbrace{\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(ALT^{\text{IE}}(Exh(\Diamond[P \vee Q])))}_{\text{Negating IE Alternatives}}$$

$$\Leftrightarrow \underbrace{\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(\Diamond P \wedge \neg\Diamond Q)}_{\text{Negating ``Only } \Diamond\text{P''}} \wedge \underbrace{\neg(\Diamond Q \wedge \neg\Diamond P)}_{\text{Negating ``Only } \Diamond\text{Q''}}$$

$$\Leftrightarrow \underbrace{\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)}_{\text{Prejacent}} \wedge \underbrace{(\Diamond P \leftrightarrow \Diamond Q)}_{\substack{\text{Both possibilities} \\ \text{or neither}}}$$

$$\Leftrightarrow \underbrace{(\Diamond P \wedge \Diamond Q)}_{\text{Free Choice}} \wedge \underbrace{\neg\Diamond(P \wedge Q)}_{\text{Exclusivity}}$$

By contrast, in the case of simple disjunction, a second round of exhaustification would yield a conjunctive inference ($[P \wedge Q]$; see Chapters 2 and 3 as well as Singh et al. 2016), which contradicts the exclusivity inference generated in the first round. This contradiction explains why adults typically do not proceed to a second round in simple disjunction. Importantly, such a contradiction does not arise in the modal environment since the Modal Conjunctive alternative is not equivalent to the free choice interpretation, as will be demonstrated in Section 3.2.

Before closing this section, it is important to note that, while Simons (2005) considers the additional exclusivity inference in modal disjunctive statements to be fully optional, this is not the case within the grammatical approach. Under this approach, the free choice inference cannot be derived without having to go through the step that derives the exclusivity inference first. The apparent optionality observed by Simons can be accounted for by assuming that adults cancel the exclusivity inference, resulting in free choice being the only visible inference. This issue, which is also a problem for characterising the children's performance, will be explored further in Section 7.

In the next section, we turn to the acquisition background relevant to this chapter and explore the possibility that children derive a Modal Conjunctive interpretation of modal disjunction.

3 Identifying modal conjunction and exclusivity in modal disjunctive statements

Previous acquisition studies investigating modal disjunctive statements showed that, with an experimental setup where one of the two disjuncts was falsified, children appeared to derive free

choice inferences at adult-like rates (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020). It was, however, premature to conclude that children interpret modal disjunctive statements like adults on the sole basis that free choice inferences are acquired as early as age five. Indeed, these studies did not assess whether children were fully adult-like with such statements as they did not test for the additional exclusivity inference. Moreover, they overlooked an alternative explanation of children's seemingly adult-like behaviour, namely, children may have interpreted modal disjunctive statements as modal conjunction instead of a true free choice interpretation. In other words, it is plausible that children showed a non-adult-like performance that was not investigated before, setting the stage for the acquisition study presented in Section 4.

In section 3.1, we present the common methodology used in the previous acquisition studies to test for the presence of a free choice inference. In Section 3.2, we introduce the *Modal Conjunctive* interpretation and point out how prior experimental setups could not tease it apart from a genuine free choice interpretation. We show how a new type of condition, specifically a *Mutually Exclusive* scenario, can make the distinction between the two interpretations. In section 3.3, we explore another aspect of the interpretation of modal disjunctive statements that has been consistently ignored in the literature: the additional exclusivity inference. To determine whether children were fully adult-like with modal disjunctive statements, and assess whether it is really optional for adults, another new type condition is required: a *Package* scenario.

3.1 Testing for free choice inferences

To investigate the generation of free choice inferences in modal disjunctive statements, experimental studies all used a common methodology: they implemented a condition that aimed to falsify the free choice inference. This was done by forbidding one of the two possibilities. Consider (21) and (22) from Chemla and Bott (2014; p. 385).

(21) **Cover story:** (Chemla & Bott, 2014; p. 385)
   a. A zoologist may save a living creature, whatever creature he or she wants.
   b. An engineer would not be allowed to save a living creature, but he or she may be allowed to save any kind of man-made, or artificial, object.

(22) **Test sentence:** (Chemla & Bott, 2014; p. 385)
   Beverly-the-engineer is allowed to save a hammer or a lion.

The cover story in (21) explicitly forbids engineers to save living beings, i.e. one of the two disjuncts is not accessible. Hence, if a free choice interpretation is generated from the test sentence in (22), then rejection is expected because Beverly, as an engineer, is not allowed to save the lion.[9] In a similar vein, acquisition studies designed conditions that rendered the free choice interpretation either true or false. Consider the two conditions in (23) and (24) used in Huang and Crain (2020; p. 14) to detect whether children were able to appropriately derive the free choice inference for (25), by accepting (23) as well as rejecting (24).

(23) **Control condition:** (Huang & Crain, 2020; p. 14)
   a. Small Dog is allowed to eat rice.
   b. He is also allowed to eat soup.

[9] Chemla and Bott (2014) explicitly controlled for the additional exclusivity inference by stating that engineers and zoologists were only allowed to save exactly one object / animal.

(24) **Critical condition:** (Huang & Crain, 2020; p. 14)
a. Big Dog is allowed to eat rice.
b. But he is not allowed to eat soup.

(25) **Test sentence:** (Huang & Crain, 2020; p. 14)
Small / Big Dog is allowed to eat rice or soup.

In the control condition, both disjuncts are permitted, which makes this situation compatible with a free choice interpretation as well as with the *Modal Inclusive* meaning of the modal disjunctive test sentence (25). On the contrary, in the critical condition, only one of the two disjuncts is accessible, which is only compatible with the Modal Inclusive meaning of (25) as illustrated in (27).

(26) **Target responses for (25) in the control condition (23):**
a. TRUE if $\Diamond(P \vee Q)$ is understood as $\Diamond(P \vee Q)$ Modal Inclusive
b. TRUE if $\Diamond(P \vee Q)$ is understood as $\Diamond P \wedge \Diamond Q$ Free Choice

(27) **Target responses for (25) in the critical condition (24):**
a. TRUE if $\Diamond(P \vee Q)$ is understood as $\Diamond(P \vee Q)$ Modal Inclusive
b. FALSE if $\Diamond(P \vee Q)$ is understood as $\Diamond P \wedge \Diamond Q$ Free Choice

In the critical condition (24), the rejection rate reached 95% in Huang and Crain (2020) and 91% in Zhou et al. (2013) and Tieu et al. (2016)[10], suggesting that children successfully derived free choice inferences in proportions nearly comparable to adults.

3.2 Teasing apart modal conjunction from free choice: Mutually exclusive scenarios

As a starting point, take the modal disjunctive statement in (28) and the two interpretations in (28a) and (28b). Under a *free choice* interpretation, the statement can be paraphrased as the conjunction of two modal propositions (28a; $\Diamond P \wedge \Diamond Q$). By contrast, under a *modal conjunction* interpretation, it refers to the conjunction of the two sub-constituents embedded under a single modal operator (28b; $\Diamond[P \wedge Q]$).

(28) Liz can buy a croissant or a donut.
a. Liz can buy a croissant and she can buy a donut. Free Choice ($\Diamond P \wedge \Diamond Q$)
b. Liz can buy a croissant and a donut. Modal Conjunction ($\Diamond[P \wedge Q]$)

Although free choice and modal conjunction look very similar, they are not logically equivalent. Modal conjunction entails the free choice interpretation (29a), but the reverse is not true (29b). For example, suppose a situation where Liz has enough money to buy one or the other pastry, but not enough to buy both pastries at the same time, the free choice reading is fine (i.e., she can buy one and she can buy the other), but the modal conjunction reading (i.e., she can buy both items) is not. Therefore, the free choice interpretation and the *Modal Conjunctive* interpretation convey distinct meanings (29c).

(29) a. $\Diamond(P \wedge Q) \Rightarrow \Diamond P \wedge \Diamond Q$
b. $\Diamond P \wedge \Diamond Q \not\Rightarrow \Diamond(P \wedge Q)$
c. Therefore $\Diamond(P \wedge Q) \not\Leftrightarrow \Diamond P \wedge \Diamond Q$

[10] Zhou et al. (2013) and Tieu et al. (2016) report the results of the same experiment.

The one-way entailment relationship between both interpretations in (29a) highlights a complication that proves to be critical for interpreting the findings of previous experimental designs. Indeed, the two interpretations share satisfying and falsifying conditions: in scenarios such as (23) and (24), it is not possible to tease apart a free choice response from a *Modal Conjunctive* one. To illustrate, compare the target responses in (31) and (32) for a modal disjunctive test sentence such as (25) under two different scenarios, (30a) and (30b). Whereas (30a) states that both disjuncts are true, only one of the two disjuncts is true in (30b). These two scenarios match the two types of conditions investigated in previous studies (e.g. (23) and (24)).

(30) a. Scenario *Two Disjuncts True*: $\Diamond P$ is true and $\Diamond Q$ is true.
b. Scenario *One Disjunct True*: $\Diamond P$ is true but $\Diamond Q$ is false.

(31) **Expected responses for (28) in the *Two Disjuncts True* scenario (30a):**
a. TRUE if $\Diamond(P \vee Q)$ is understood as $\Diamond P \wedge \Diamond Q$ — Free Choice
b. TRUE if $\Diamond(P \vee Q)$ is understood as $\Diamond(P \wedge Q)$ — Modal Conjunction

(32) **Expected responses for (28) in the *One Disjunct True* scenario (30b):**
a. FALSE if $\Diamond(P \vee Q)$ is understood as $\Diamond P \wedge \Diamond Q$ — Free Choice
b. FALSE if $\Diamond(P \vee Q)$ is understood as $\Diamond(P \wedge Q)$ — Modal Conjunction

The conclusion in prior studies that acceptance of the test sentence in the first scenario (31a) and rejection in the second scenario (32a) necessarily reflects free choice inferences is too fast. As shown in (31b) and (32b), the exact same response pattern also emerges on another reading that is not free choice, namely if the test sentence is incorrectly interpreted as a *Modal Conjunctive* statement. This is due to the entailment relationship between the two interpretations: whenever the free choice interpretation is falsified, modal conjunction is falsified as well. In a scenario where Liz has the possibility to buy the croissant but not the donut, the verification procedure of the test sentence Liz can buy a croissant or a donut does not differ for the two readings, whether Liz has the possibility to buy whichever pastry she chooses (Free Choice; (28a)) or Liz has the possibility to buy both the croissant and the donut (Modal Conjunction; (28b)). In both cases, the sentence is expected to be rejected when Liz does not have the possibility to buy the donut.

Put differently, neither a scenario in which both disjuncts are true (31) nor a scenario that falsifies one of the two disjuncts (32) can effectively tease apart a free choice interpretation from a *Modal Conjunctive* one. However, there exists another type of scenario that can disambiguate both interpretations: mutually exclusive contexts. To illustrate, consider a case of epistemic free choice in (33) from Zimmermann (2000).

(33) John might be in Paris or in London. (Zimmermann, 2000)
a. John is in Paris. $\Diamond P$
b. John is in London. $\Diamond L$
c. John is in Paris and in London. $\Diamond(P \wedge L)$

The sentence in (33) is logically compatible with three situations, given in (33a) to (33c). If a free choice interpretation is calculated, the sentence is compatible with John being either in London (33a) or in Paris (33b), but not with John being both in Paris and in London at the same time (33c). This is because the latter situation is constrained by world knowledge: it is impossible for an individual to be at two separate places at the same time, given that Paris

and London are two independent places in the world. In other words, John being in Paris (33a) and John being in London (33b) are mutually exclusive situations that cannot be true simultaneously. However, if the sentence is interpreted as modal conjunction, not only does it have to be compatible with John being in Paris (33a) and John being in London (33b), because of the entailment relationship between the free choice interpretation and modal conjunction, but it also has to be compatible with John being both in Paris and in London simultaneously (33c). This directly contradicts world knowledge, unless it is discovered that Paris and London are in fact the same city (which they are not), or that John possesses the superpower to be at several independent places at the same time (but this is no longer a mutually exclusive scenario). Thus, while a free choice interpretation is perfectly valid in both mutually exclusive and non-mutually exclusive scenarios, a *Modal Conjunctive* interpretation is only satisfied in non-mutually exclusive scenarios. Table 1 below summarises which situation is permitted according to the type of scenario.

Situation		**Mutually Exclusive**	**Non-mutually Exclusive**
John is in Paris.	$\Diamond P$	✓	✓
John is in London.	$\Diamond L$	✓	✓
John is in Paris and in London.	$\Diamond(P \wedge L)$	×	✓

Table 1: Permitted situations for mutually and non-mutually exclusive scenarios.

By using conditions taking the form of the scenarios in (30a) and (30b), it is impossible to confidently conclude that children have reached adult-like performance in interpreting modal disjunctive statements. However, since modal conjunction conveys an additional layer of information, namely that the first and the second disjuncts are both accessible simultaneously, it is possible to tease apart a *Modal Conjunctive* interpretation from a free choice interpretation. This can be achieved by introducing a mutually exclusive scenario, on a par with (33), that specifically satisfies the free choice interpretation but falsifies modal conjunction. Take the scenario in (34) where the mutually exclusive component is explicitly expressed (and does not rely on world-knowledge).

(34) **Mutually Exclusive scenario:**
   a. (i) Liz has the possibility to buy a croissant. $\Diamond P$
      (ii) Liz has the possibility to buy a donut. $\Diamond Q$
   b. Liz does not have the possibility to buy both a croissant and a donut. $\neg\Diamond(P \wedge Q)$

In (34a), Liz has the possibility to buy whichever pastry she chooses, which satisfies both the free choice and the modal conjunction interpretations. Recall that this is necessary since falsifying free choice also falsifies modal conjunction. In (34b), however, Liz does not have the possibility to buy both a donut and a croissant (for instance, because she does not have enough money, or because her mother doesn't allow her): if Liz buys the croissant, she can no longer buy the donut, and vice versa. Buying one of the two pastries automatically excludes the other from the range of buyable pastries. In other words, Liz buying the croissant and Liz buying the donut are mutually exclusive situations. As a consequence, the free choice interpretation is satisfied but modal conjunction is not (35).

(35) **Expected responses for (28) in the *Mutually Exclusive* scenario (34):**
a. TRUE if $\Diamond(P \vee Q)$ is understood as $(\Diamond P \wedge \Diamond Q)$ Free Choice
b. FALSE if $\Diamond(P \vee Q)$ is understood as $\Diamond(P \wedge Q)$ Modal Conjunction

Importantly, neither Zhou et al. (2013), Tieu et al. (2016) or Huang and Crain (2020) incorporated a mutually exclusive condition in their experimental setup. Thus, it was premature to conclude on the basis of these studies that children of age 4 to 5 actually derive a genuine free choice inference at adult-like rates. Instead, it is possible that some of the allegedly adult-like children gave an adult-like response for a non-adult-like reason, namely modal conjunction. This is not unlikely given that conjunctive interpretations of simple disjunction were reported in several studies with preschoolers in a wide range of comprehension tasks (Braine & Rumain, 1981; Cochard et al., 2023; Paris, 1973; Singh et al., 2016; Tieu et al., 2017; Bleotu et al., 2023) as well as with toddlers in an eye-tracking study (Lobina et al., 2023a). It is thus plausible that children assign a *Modal Conjunctive* interpretation to modal disjunctive statements (36).

(36) **Extending conjunctive interpretations to modal disjunction:**
a. Since $(P \vee Q)$ is interpreted as $(P \wedge Q)$
b. Then it is plausible that $\Diamond(P \vee Q)$ is interpreted as $\Diamond(P \wedge Q)$

The possibility that children might in fact not derive free choice inferences at adult-like rates has direct consequences for the current understanding of children's mastery of disjunction in simple disjunctive sentences. In Singh et al.'s (2016) explanation of the conjunctive interpretation of simple disjunctive statements, it is predicted that conjunctive children know how to derive a free choice inference, as it involves the same exhaustification reasoning à la Fox (2007). But, now that free choice and modal conjunction are both legitimate candidates to explain children's responses to modal disjunctive statements, it becomes critical to ask whether Singh et al.'s explanation can still be maintained. As will be proposed in Section 7, a formal implementation relying on a local pragmatic reasoning provides a unified account of both the *Modal Conjunctive* interpretation in modal disjunction, and the conjunctive interpretation in simple disjunction. This approach preserves Singh et al.'s (2016) core assumptions that children are capable of pragmatically enriching sentence meaning (through exhaustification), yet lack access to the conjunctive alternative within the set of relevant alternatives.

3.3 Testing for the exclusivity inference: Package scenarios

Modal disjunctive statements typically yield two complementary inferences: first, it is possible to access each disjunct individually (37a), that is the free choice inference. Second, it is not possible to access both disjuncts simultaneously (37b), that is the exclusivity inference. The latter has been argued to be optional (Simons, 2005) and, as such, has attracted little interest in the literature.

(37) Liz can buy a croissant and she can buy a donut...
a. ...and possibly both. $\Diamond P \wedge \Diamond Q$
b. ...but not both. $\Diamond P \wedge \Diamond Q \wedge \neg(P \wedge Q)$

Not deriving the exclusivity inference on top of a free choice inference means the speaker is open to three possibilities: that Liz only buys the croissant, that she only buys the donut, and that she buys both the donut and the croissant simultaneously. Alternatively, deriving the exclusivity inference means that the speaker is open to the possibilities that Liz buys only the croissant and that she buys only the donut, namely free choice, but not that she buys both the

croissant and the donut at the same time.

Moreover, while two non-adult-like non-exclusive interpretations have been reported for children for simple disjunction statements, an *inclusive* interpretation (Boster & Crain, 1993; Chierchia et al., 2001b, 2001a; Singh et al., 2016; Tieu et al., 2017; Cochard et al., 2023; Sauerland & Yatsushiro, 2018; Pagliarini et al., 2018a; Goro et al., 2006; Huang & Crain, 2020; Su, 2014; Su & Crain, 2010; Bleotu et al., 2023) and a *conjunctive* interpretation (Braine & Rumain, 1981; Paris, 1973; Tieu et al., 2017; Singh et al., 2016; Lobina et al., 2023a; Cochard et al., 2023; Bleotu et al., 2023) as demonstrated in Chapter 3, none of the child studies on modal disjunction (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020) has asked so far whether children were able to derive the additional exclusivity inference in modal disjunctive statements. Moreover, though Zhou et al. (2013) did compare the derivation rates of the regular exclusivity inference and the free choice inference, the derivation rate of the exclusivity inference was only tested through a simple disjunctive statement.[11] As a consequence, none of the conditions in these previous studies allowed for identification of this exclusivity inference in modal disjunctive statements. To illustrate, take the expected responses in (39) and (40) for the two types of scenarios in (30), repeated here in (38): the Two Disjuncts True (38a) and One Disjunct True scenarios (38b).

(38) a. Scenario *Two Disjuncts True*: $\Diamond P$ is true and $\Diamond Q$ is true.
b. Scenario *One Disjunct True*: $\Diamond P$ is true but $\Diamond Q$ is false.

(39) **Expected responses for (37) in the *Two Disjuncts True* scenario (38a):**
a. TRUE if $\Diamond(P \vee Q)$ is understood as $\Diamond P \wedge \Diamond Q$ – Exclusivity
b. TRUE if $\Diamond(P \vee Q)$ is understood as $\Diamond P \wedge \Diamond Q \wedge \neg\Diamond(P \wedge Q)$ + Exclusivity

(40) **Expected responses for (37) in the *One Disjunct True* scenario (38b):**
a. FALSE if $\Diamond(P \vee Q)$ is understood as $\Diamond P \wedge \Diamond Q$ – Exclusivity
b. FALSE if $\Diamond(P \vee Q)$ is understood as $\Diamond P \wedge \Diamond Q \wedge \neg\Diamond(P \wedge Q)$ + Exclusivity

Here, the truth-conditions are the same for both interpretations of the test sentence Liz can buy a croissant or a donut, whether exclusivity is derived or not. But, it is possible to create a scenario where the free choice inference is satisfied but the exclusivity inference is not. Such a scenario must allow for the possibility of buying both disjuncts, satisfying free choice, and furthermore for the impossibility of buying one without the other, falsifying the exclusivity inference. More precisely, in this case, it is only allowed to buy both disjuncts simultaneously, as a package. Take (41) as an illustration of a *Package* scenario.

(41) **Package scenario:**
a. (i) Liz has the possibility to buy a croissant. $\Diamond P$
(ii) Liz has the possibility to buy a donut. $\Diamond Q$
b. Liz only has the possibility to buy both a croissant and a donut. $\Diamond(P \wedge Q)$

In (41), Liz is given the possibility to buy a croissant and donut (41a), satisfying the free choice interpretation. But, she is not given the possibility to buy the croissant or the donut individually: she must buy the croissant and the donut packaged together, hence falsifying exclusivity (41b). Notice that the *Package* scenario also satisfies the *Modal Conjunctive* interpretation.

[11] For a direct comparison of modal disjunction and simple disjunction within the same children, see Bleotu et al. (2024b).

In the next section, we outline the rationale behind the present study, exploring the hypothesis that some children interpret modal disjunctive statements as modal conjunction. We also present a novel experimental design incorporating both a *Mutually Exclusive* condition and a *Package* condition to disentangle modal conjunction from free choice interpretations.

4 Present study

Previous acquisition studies investigating modal disjunctive statements (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020) only distinguished the target free choice interpretation from a *Modal Inclusive* interpretation, where no inference arises. The present study seeks to extend existing experimental paradigms by adding new conditions that specifically test the *Modal Conjunctive* interpretation and the exclusivity inference. The focus on modal conjunction is motivated by the insight presented above that children's alleged adult-like responses to modal disjunctive statements in prior studies can in principle follow from two alternative explanations: either children derived a genuine free choice inference, or they gave a non-adult-like *Modal Conjunctive* interpretation. Crucially, since the free choice interpretation and modal conjunction share verifying and falsifying procedures, existing experimental setups could not tease the two apart. For this reason, it is premature to conclude on the basis of these prior studies that children have fully acquired the free choice inference.

To tease apart the genuine free choice and the *Modal Conjunctive* interpretations, a new disentangling condition is necessary, namely a *Mutually Exclusive* scenario in which free choice is satisfied but modal conjunction is not, repeated below in (42) from Section 3.2.

(42) **Mutually Exclusive scenario:**
   a. Liz has the possibility to buy a croissant and the possibility to buy a donut.$\Diamond P \wedge \Diamond Q$
   b. Liz does not have the possibility to buy both a croissant and a donut. $\neg\Diamond(P \wedge Q)$

By investigating children's interpretation of modal disjunctive sentences with a larger set of scenarios than prior studies, the present study seeks to answer the questions in (43).

(43) **Research questions:**
   How do preschoolers interpret modal disjunctive statements?
   a. To what extent do preschoolers derive genuine free choice inferences?
   b. To what extent do they derive the additional exclusivity inference?

First, we investigate whether children truly derive an adult-like free choice inference in modal disjunctive statements. If they do, the next question is whether this reflects a genuine free choice inference or, rather, a *Modal Conjunctive* interpretation in disguise. Similar to children's non-adult-like interpretations of simple disjunctive statements (e.g., *conjunctive* or *inclusive* readings), it is possible that, for modal disjunctive sentences too, children either adopt a *Modal Conjunctive* interpretation or a *Modal Inclusive* disjunctive interpretation.

Second, given that the exclusivity inference of simple disjunctive statements is not well established by age five (Boster & Crain, 1993; Chierchia et al., 2001b, 2001a; Singh et al., 2016; Tieu et al., 2017; Cochard et al., 2023; Sauerland & Yatsushiro, 2018; Pagliarini et al., 2018a; Goro et al., 2006; Huang & Crain, 2020; Su, 2014; Su & Crain, 2010; Bleotu et al., 2023; Braine & Rumain, 1981; Paris, 1973; Lobina et al., 2023a), it is plausible that children do not generate this inference in modal disjunctive statements either. On top of disentangling a free choice interpretation from a *Modal Conjunctive* one, our experiment therefore also aims to investigate whether children derive the exclusivity inference (42b). To this end, we

introduce another new scenario that satisfies free choice, but falsifies exclusivity, namely the *Package* scenario, repeated in (44) from Section 2.2. Notice that the adult control sample will furthermore contribute new insights about the derivation rate of the exclusivity inference, given that such data is mostly lacking in adult experimental studies investigating modal disjunctive statements.

(44) **Package scenario:**

a. (i) Liz has the possibility to buy a croissant. $\Diamond P$

(ii) Liz has the possibility to buy a donut. $\Diamond Q$

b. Liz only has the possibility to buy both a croissant and a donut. $\Diamond(P \wedge Q)$

By combining the absence or presence of free choice and exclusivity inferences, four possible interpretations for modal disjunctive statements can be identified, with modal conjunction as a fifth possible one, as summarised in Table 2. As will be detailed in Section 7, each of the interpretations in Table 2 can be accounted for within the grammatical approach with additional assumptions such as the presence or the absence of the conjunctive alternative (Singh et al., 2016) and the locus of pragmatic enrichment.[12] Specifically, we take that the *Modal Conjunctive* interpretation is derived if children lack the conjunctive alternative and apply the enrichment mechanism locally, that is below the modal.

Interpretation	**Status**	**Logical form**	**Free Choice**	**Exclusivity**
Free Choice with Excl.	Target	$\Diamond P \wedge \Diamond Q \wedge \neg\Diamond(P \wedge Q)$	✓	✓
Free Choice without Excl.	Target	$\Diamond P \wedge \Diamond Q$	✓	×
Only Exclusivity	Non-target	$\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)$	×	✓
Modal Inclusive	Non-target	$\Diamond(P \vee Q)$	×	×
Modal Conjunction	Non-target	$\Diamond(P \wedge Q)$	×	×

Table 2: General characteristics of possible interpretations of modal disjunctive statements. "Excl." = Exclusivity.

This study contributes to the acquisition, semantics, and pragmatics literature on modal disjunction by more closely examining the extent to which children exhibit adult-like interpretations of modal disjunctive statements. First, as discussed in Section 3, we show that prior studies overlooked an alternative explanation for apparent adult-like free choice interpretations, namely, modal conjunction. We further pointed out that a truly adult-like understanding of modal disjunction also entails deriving an additional exclusivity inference. To address both these issues, we designed a novel experimental setup incorporating two new types of conditions: mutually exclusive and package scenarios. Second, we argue that the full range of interpretive patterns in Table 2 can be accounted for within a unified grammatical approach, under the assumption that children are capable of producing pragmatically enriched meanings, though not necessarily in the same way as adults.

[12] In Section 7, we speculate about a third parameter: the possibility for children to not pursue further the exhaustification procedure after the first round. In particular, this will have consequences for the *Only Exclusivity* pattern of interpretation.

5 Designing a novel setup to investigate free choice inferences

This section presents a novel setup inspired by Liu (2019) to investigate the derivation of the free choice and the exclusivity inferences. The design of the experiment introduces two new conditions: a Mutually Exclusive condition that allows us to identify *Modal Conjunctive* interpreters and a Package condition that investigates whether or not the exclusivity inference is derived. Section 5.1 presents information about the participants and 5.2 outlines the procedure of our experiment. Section 5.3 presents the three critical conditions of the experiment and the expected response patterns for different possible interpretations.

5.1 Participants

68 native French children (range = 3;11−6;9, M = 5;5) participated in the experiment. Children were recruited at school. To be included in the study, participants had to be native French speakers and not have any known cognitive, visual or hearing impairments. In addition, 40 native French adults were recruited using Prolific.[13] Adults were paid £1.50 for a 10-minutes advertised experiment, complying with the recommended hourly rates set by Prolific. Children did not receive any compensation as the experiment was scheduled during their school time by their teachers.

The experiment, including the recruiting method, the stimuli and the procedure received approval from the CEDIS ethics committee of Nantes Université (IORG0011023) and was assigned identification number 06112023-1.

5.2 Task and procedure

Taking inspiration from the lottery machine paradigm from Liu (2019), a truth-value judgement task in description mode (Crain & Thornton, 1998) using a setup with coins was designed for our study. Participants had to judge a sentence describing the picture of a shop-selling situation as in Figure 1. They were told that the shop employee (the character at the bottom of Figure 1, the same in all items) tries to help customers (e.g. the character at the top) by telling them what they can buy with the number of coins in their purse. Participants had to decide whether or not the shop employee gave a successful description of the picture by pressing either a thumbs-up button (correct) or a thumbs-down button (incorrect), as illustrated in Figure 2.

Each picture contains four key elements: the bottom character, the Koala, is the shop employee. This character utters the test sentence and appears in all stimuli. Participants were told that the shop employee is a newcomer and, as such, he can make mistakes since it is his first day at work. The top character is the customer; this animal varies across pictures. Each customer comes to the shop with a certain number of coins in their purse. For instance, Figure 1 depicts a condition where the bear arrives in the shop with one coin in her purse. Finally, the shop stand shows two spaces, each containing a food item with its price beneath. Here, the croissant costs one coin and the donut costs two coins. After hearing the test sentence, the thumbs-up and thumbs-down buttons appear on the right side of the screen. The position of those buttons was counterbalanced between participants, some of them seeing the configuration in Figure 2 and the others the opposite configuration.

The experiment was coded for the web, using OpenSesame to compile the script (Mathôt et al., 2012; Mathôt & March, 2022) and a private JATOS (Lange et al., 2015) server to host the experiment and the data. The children were tested using a tablet. The adults participated in a web-based version of the experiment.

[13] https://www.prolific.com/

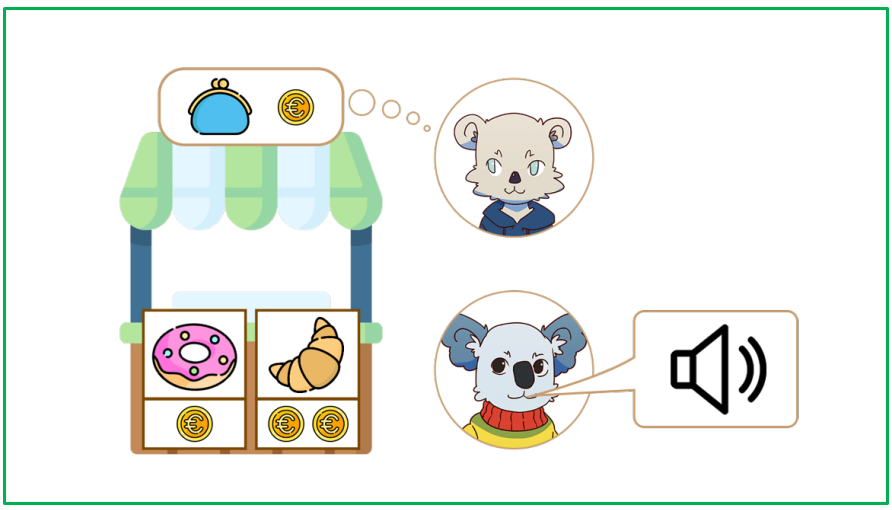
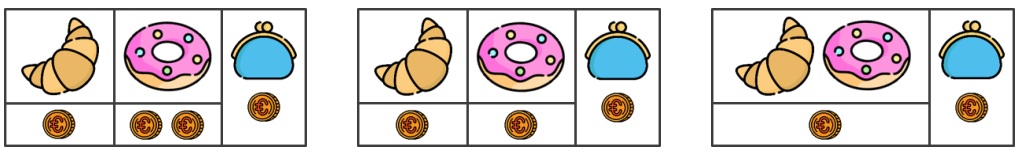


Figure 1: Sample item for *Liz can buy a croissant or a donut.* The Koala at the bottom speaks the test sentence.

Figure 2: Sample item for *Liz can buy a croissant or a donut.* Response phase.

5.3 Conditions and predictions

The experiment included the three critical conditions in Figure 3. The conditions varied the price of the food and the number of coins in the purse. The display of food items and coins was the same with the notable exception of the Package condition in Figure 3c. The design was within-subjects and participants saw six items of each condition (18 critical items, 12 control items, 30 items in total). Six items per condition allowed us to determine the consistency in a given participant's individual answer pattern, which was needed to compare their interpretations across the three critical conditions in a cluster analysis.



(a) One Disjunct True **(b)** Mutually Exclusive **(c)** Package

Figure 3: Critical conditions

For each condition, participants heard a lead-in fragment introducing the number of coins in the purse, followed by a modal disjunctive statement, as in (45).

(45) Avec une pièce, Liz l'ours **peut** acheter un croissant **ou** un donut.
with one coin Liz the.bear can.3SG.PRS buy.INF a croissant or a donut
"With one coin, Liz the bear can buy a croissant or a donut."

The *One Disjunct True* condition was designed in the same spirit as in previous studies: one of the disjuncts is accessible while the other is not. In Figure 3a, with one coin, it is true that the customer can buy a donut, but it is false that she can buy a croissant, as the latter costs two coins. Adults were expected to reject this condition, because the free choice inference does not hold here. Moreover, the *Modal Conjunctive* interpretation does not hold either, for the same reason, and also because the customer does not have enough coins to buy the croissant and the donut together, as a package. Target-like rejection of this condition reflects either the adult free choice interpretation, but is also compatible with a *Modal Conjunctive* interpretation; this condition on its own cannot distinguish between the two. Furthermore, a yes-answer to this condition is a clear signal of a non-adult-like interpretation, though it is not yet possible to determine whether it is a *Modal Inclusive* interpretation or an *only exclusivity* interpretation.

The *Mutually Exclusive* condition is the critical new condition which, alongside the *One Disjunct True* condition, allows us to disentangle a genuine free choice interpretation from a *Modal Conjunctive* interpretation. Here, the possibility of buying both food items is impossible, because the customer does not have enough coins to buy both food items at the same time, thus excluding a *Modal Conjunctive* reading. Crucially, it allows a free choice interpretation, as it is possible, with one coin as in Figure 3b, to buy either one or the other pastry, whichever she chooses. Only on the basis of an answer pattern where a consistent yes-answer to the *Mutually Exclusive* condition is paired with a consistent no-answer to the *One Disjunct True* condition, can it be confidently concluded that the adult-like free choice inference is derived.

In the *Package* condition, the display of the pastries and price in the food stand differs from the other two conditions. In Figure 3c, the package containing both the donut and the croissant costs one coin. It is not possible to get the croissant without getting the donut, and conversely. This condition serves two purposes: first, it checks whether the exclusivity inference is derived. Within the grammatical approach, rejection is expected. Under Simons's (2005), however, this inference is optional and so acceptance is also target-like. Combined with the two other conditions, the *Package* condition can thus distinguish two possible adult-like grammars that both yield a genuine free choice inference, but differ in the derivation of the exclusivity inference. Second, it gives a chance to a *Modal Conjunctive* interpreter to give a positive answer in one of the critical conditions.

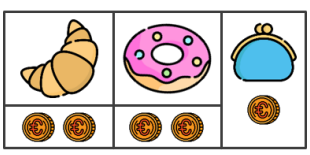
Table 3 summarises the expected response patterns for each of the aforementioned interpretations. If the conclusion from previous studies that children can derive a genuine free choice inference is correct, then it is expected that they will follow one of the two possible adult-like target patterns depending on whether or not they draw the exclusivity inference: the *Free Choice with Exclusivity* or the *Free Choice without Exclusivity* response patterns. However, if our hypothesis is on the right track and children may interpret modal disjunctive statements as modal conjunction instead, then a subset of children are expected to fit the *Modal Conjunctive* response pattern. The design furthermore, allows to distinguish two additional non-adult-like response patterns which both lack the free choice inference: the *Only Exclusivity* and the *Modal Inclusive* response patterns, which only differ by the presence or absence of the exclusivity inference.

		 One Disjunct True	 Mutually Exclusive	 Package
Target	Free Choice with Excl. $\Diamond P \wedge \Diamond Q \wedge \neg\Diamond(P \wedge Q)$	×	✓	×
	Free Choice without Excl. $\Diamond P \wedge \Diamond Q$	×	✓	✓
Non-target	Modal Conjunction $\Diamond(P \wedge Q)$	×	×	✓
	Only Exclusivity $\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)$	✓	✓	×
	Modal Inclusive $\Diamond(P \vee Q)$	✓	✓	✓

Table 3: Expected answer schemes for each of the predicted interpretation patterns. "✓" means that acceptance is expected, "×" means that rejection is expected. "Excl." = Exclusivity.

Besides the three critical conditions, two types of controls were included in the experiment, Figure 4. One type of control was always true and the other always false. In true controls, each food costs one coin and the customer has two coins in her purse. The customer has enough coins to buy the croissant and the donut. The false counterpart of control items makes none of the two pastries accessible. The croissant costs two coins and the donut costs two coins as well. But the customer cannot buy anything since she only has one coin in her purse.

(a) Two disjuncts true (always true)



(b) No disjunct true (always false)

Figure 4: Control conditions

Finally, twelve filler items served the purpose of balancing the number of yes and no-responses. Six of them asked about elements of the display to make sure that participants were paying attention to the picture and to the recorded sentence, for instance, by stating the price of a given disjunct as in (46). The other six checked if participants understood the coin system, for instance, by stating what could be purchased with a certain amount of coins as in (47).

(46) Un croissant coûte une / deux pièce(s).
a croissant cost.3SG.PRS one / two coin(.PL)
"A croissant costs one/two coin(s)."

(47) Avec une pièce, Liz l'ours peut acheter un croissant.
with one coin Liz the.bear can.3SG.PRS buy.INF a croissant
"With one coin, Liz the bear can buy a croissant."

All items were compiled into four pseudo-randomised lists, preceded by five training items which were similar to the fillers. Critical items were systematically separated by controls or fillers and never immediately followed another critical item of the same condition. Training items were used to familiarise children with the task. Each training item introduced a different type of display (one coin, two coins, a package). Children were allowed to repeat the training session once. Children who repeatedly failed on training items were automatically excluded from the experiment. In total, participants saw 47 items (18 criticals, 12 controls, 12 fillers and 5 trainings), all presented together in one session of approximately 20 minutes for children and 10 minutes for adults. Except for the training items, participants were not allowed to hear the audio stimuli again. Prosody was neutral, making sure that the disjunctive statement did not carry any pitch rise, especially not on the disjunctive word *ou* "or".

Children were occasionally asked to provide justifications for their responses. The aim, when possible, was to obtain at least one justification per critical condition for each child. However, justifications were not systematically collected for every item, in order to avoid lengthening the experiment excessively and distracting children from the task.

6 Results

Group results and mixed model analyses are reported in Section 6.1 while individual analyses are reported in section 6.2. A brief analysis of the justifications is given in section 6.3. Exclusion of participants from analysis was based on their performance on controls and fillers. Participants were not allowed to make more than one error out of six true controls, no more than one error out of six false controls and no more than three errors out of twelve yes/no filler items. Four children were excluded for specifically failing at true controls. No children failed specifically at false controls. Seven other children were excluded for failing simultaneously at both controls and fillers, with no notable difference between the type of control. Two adults were excluded for failing at true controls, whereas another adult failed specifically at false controls. After exclusion, 57 children (range = 3;11−6;9, M = 5;5) and 37 adults (range = 22−67, M = 34) were included in the analysis.

6.1 Group-level mixed models analysis

To examine the contrasts between groups (adults vs. children) as well as within groups (adults only and children only), a series of mixed-effects model analyses was performed. Statistical analyses were done within the R environment (R Core Team, 2023). Mixed models were computed using the *lme4* package (Bates et al., 2015) to fit binomial generalised linear mixed models and the *blme* package (Chung et al., 2013; Dorie et al., 2024) to control for a case of separation in the adult data. To investigate further contrasts in the data, post-hoc pairwise comparisons were computed using the *emmeans* package (Lenth, 2025).

Figure 5 reports the general performance of adults and children in each condition.[14] At first glance, it appears that children performed differently than adults in the three critical conditions. While adults agreed on the rejection of the *One Disjunct True* condition (1.8% of yes responses) and the acceptance of the *Mutually Exclusive* condition (100%), there was some acceptance of the One Disjunct True (27.2%) and no full acceptance of the *Mutually Exclusive* condition in the children (76.2%). The Package condition also showed a contrast between adults and children. While there is no firm acceptance or rejection in either group, children mostly accepted this condition (81.9%) and adults mostly rejected it (31.5%).

[14] See Table C.2 in Appendix C for the complete descriptive statistics.

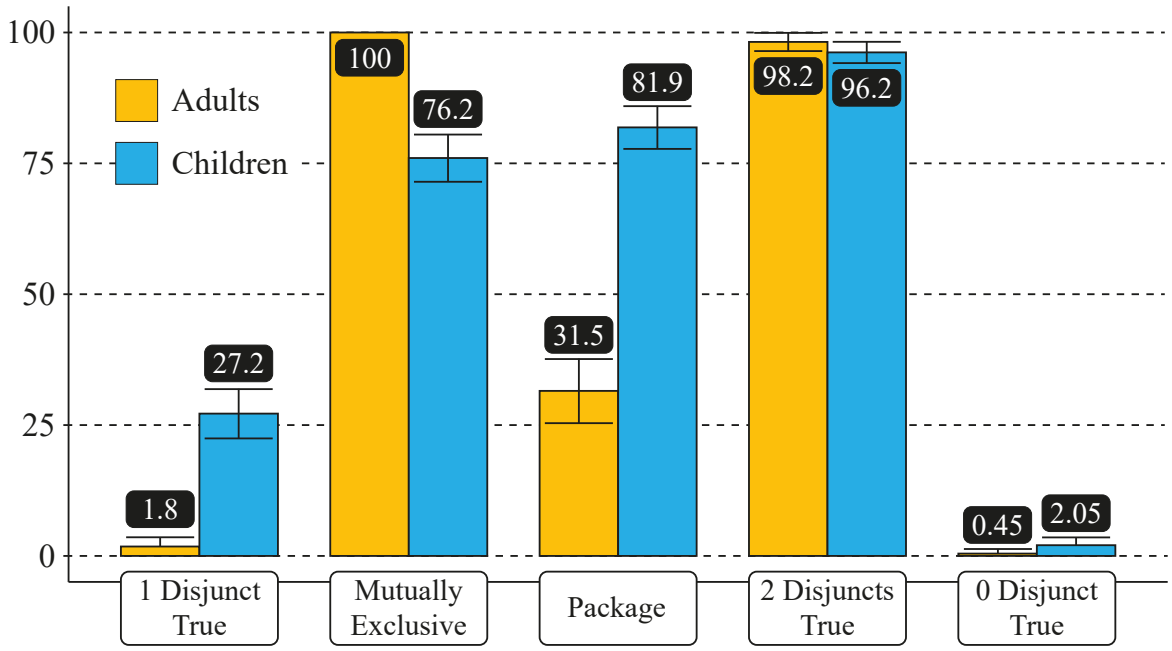


Figure 5: Mean of acceptance for each condition for both adults and children. Whiskers represent a 95% confidence interval.

To compare adults' and children's performance, a penalised generalised mixed-effects model was run using the *bglmer* function from the *blme* package.[15] The model specification was a priori hypothesis-driven: the binary responses from participants (yes/no) were regressed against the critical conditions (*One Disjunct True*, *Mutually Exclusive* and *Package*), the group (adults vs. children) and the interaction of the two (condition by group). Participant-level random effects were included to reflect individual variation, to which we added the random slope of condition, since it is hypothesised that this fixed-effect varies across subjects. The random effects of the list and the items were not included, as the model failed to converge otherwise.[16] A ridge penalty that corresponded to a normal prior distribution with a mean of zero and a standard deviation parameter of 5 for all coefficients in the model was applied for the penalisation.[17] Adults and the *One Disjunct True* condition were taken as reference points

[15] The adults' responses in the *Mutually Exclusive* condition constitute a case of quasi-complete separation. In such cases, a penalised logistic regression is required to confidently interpret the results. Indeed, the unpenalised model computed with the *glmer* function, given in Table C.2 in Appendix C, outputs unreasonably large estimates with even larger standard errors, a clear indication of separation. Quasi-complete separation occurs when, for a cell defined by a specific combination of fixed-effect levels, all observations of a binary response are either positive (yes-answer) or negative (no-answer), which corresponds to our case. Such scenarios, common in linguistics, severely compromise the trustworthiness of mixed-effects models: they generate very large coefficients and even larger standard errors, rendering the estimates meaningless and unsuitable for hypothesis testing. A solution to handle separation in binary data is to compute penalised logistic regressions (Firth, 1993), which regularise coefficients to make them interpretable. An alternative possibility would be to adopt a Bayesian approach, which can also mitigate separation issues, but this was not pursued in the present dissertation. See Kimball et al. (2019) and Clark et al. (2023) for an in-depth discussion of how to handle cases of separation specifically in linguistic data.

[16] However, a comparison of different random effect structures with null models, computed with *glmer* function (Bates et al., 2015), revealed that the addition of the list and the items does not significantly improve the model (AIC = 1164 for the model containing both the list and the items vs. AIC = 1154 for the model containing none). This suggests that neither the list nor the items had a decisive effect on the interpretation of the test sentence.

[17] A smaller deviation implies a stronger penalisation and shrinks the estimates toward zero. On the contrary a

for the regression. The coefficients of the model are reported below in Table 4.

Predictor	**Estimate (β)**	**SE**	z	p
Intercept	−4.63	0.56	−8.21	$< .001^{***}$
Mutually Exclusive	10.26	0.79	13.04	$< .001^{***}$
Package	2.62	0.87	3.00	$.003^{**}$
Children	2.49	0.66	3.75	$< .001^{***}$
Mutually Exclusive × Children	−5.51	0.84	−6.58	$< .001^{***}$
Package × Children	3.69	1.23	3.00	$.003^{**}$

Table 4: Coefficients for the "Adults vs. Children" penalised mixed-effects model.

The model revealed a main effect of each of the conditions as well as a main effect of the group. Moreover, the model shows that the interaction between the group and the conditions was significant, suggesting that children significantly differ from adults on every condition. This is furthermore confirmed by the post-hoc pairwise comparisons between groups given in Table 5.

Contrast	**Estimate (β)**	**SE**	z	p
One Disjunct True	−2.49	0.66	−3.75	$< .001^{***}$
Mutually Exclusive	3.02	0.78	3.86	$< .001^{***}$
Package	−6.18	1.23	−5.00	$< .001^{***}$

Table 5: Post-hoc pairwise comparisons: "adults vs. children" contrasts.

Children are more likely to accept the *One Disjunct True* and the *Package* conditions than the adults, while they are less likely to accept the *Mutually Exclusive*. Notice that the large estimate on the *Package* condition reflects the stark contrast observed between children and adults in Figure 5.

The within-group contrasts, given in tables 6 and 7, show further evidence that children and adults are statistically distinct groups. For instance, the difference between the *One Disjunct True* and the *Mutually Exclusive* conditions is high in magnitude in the adult subset data. This is expected as adults show full acceptance and rejection rates in the two conditions, respectively. On the contrary, although children show a similar tendency to reject the *One Disjunct True* condition more than the *Mutually Exclusive* condition, the effect size is twice smaller than for the adults. Turning to the *Package* condition, it is worth noting that the acceptance rate of the *Package* condition is significantly different from the *One Disjunct True* condition as well as the *Mutually Exclusive* condition. In other words, the performance on the *Package* condition significantly differed from a true acceptance and from a true rejection. This suggests that either participants were at-chance on this condition, or that there are two subpopulations within the adults (see individual results in Section 6.2). On the contrary, children accepted the *Package* condition at a rate close to the *Mutually Exclusive* condition, which explains the absence of difference between the two conditions.

To provide a more accurate understanding of the variation within the children and to

bigger deviation implies a weaker degree of correction of the estimates. We chose 5 as per recommendations from Clark et al. (2023), which allows for some variation in the model without over-fitting it.

Contrast	Estimate (β)	SE	z	p
One Disjunct True × Mutually Exclusive	−10.26	0.79	−13.04	$< .001^{***}$
One Disjunct True × Package	−2.62	0.87	−3.00	$.008^{**}$
Mutually Exclusive × Package	7.64	1.02	7.47	$< .001^{***}$

Table 6: Post-hoc pairwise comparisons: between conditions contrasts for the adult group. p values were Tukey-adjusted.

Contrast	Estimate (β)	SE	z	p
One Disjunct True × Mutually Exclusive	−4.75	0.58	−8.16	$< .001^{***}$
One Disjunct True × Package	−6.30	0.89	−7.08	$< .001^{***}$
Mutually Exclusive × Package	−1.55	0.96	−1.61	.242

Table 7: Post-hoc pairwise comparisons: between conditions contrasts for the child group. p values were Tukey-adjusted.

investigate whether age played a role, a generalised mixed-effects model was run using the *glmer* function from the *lme4* package. The binary responses from participants (yes/no) were regressed against the critical conditions (*One Disjunct True*, *Mutually Exclusive* and *Package*) and the age in months. Participant-level random effects were included with a slope on conditions. Random effects for the list and the items were included as well. The coefficients of this model are given in Table 8. The model revealed main effects of the three conditions for children but no effects of age. Notice that an ANOVA for linear models showed that an additive model was more successful in explaining the variance than an interaction model ($\chi^2(2) = 0.087; p = 0.95$), suggesting that there was no interaction between the acceptance rate for each condition and the age of participants.

Predictor	Estimate (β)	SE	z	p
Intercept	−2.16	0.53	−4.06	$< .001^{***}$
Mutually Exclusive	4.72	0.60	7.94	$< .001^{***}$
Package	6.30	1.27	4.97	$< .001^{***}$
Age in months	−0.19	0.36	−0.54	.592

Table 8: Coefficients for the "Children Only" mixed-effects model.

6.2 Individual results

6.2.1 Individual patterns

Individual results were analysed to determine if different interpretive patterns appeared. First, assessing consistency for each participant, the responses for each condition were aggregated into a score value ranging from 0 to 6 (which corresponded to the 6 items per condition), where 0 means that the participant consistently rejected the test sentence and 6 indicates that she consistently accepted the test sentence in a specific condition. The distribution of the score values for adults and children is given in Figure 6.

As pointed out above for the group results, adults agreed in rejecting the *One Disjunct True* condition and accepting the *Mutually Exclusive* condition. However, they disagreed on the *Package* condition. There turned out to be two subsets: the majority consistently rejected the

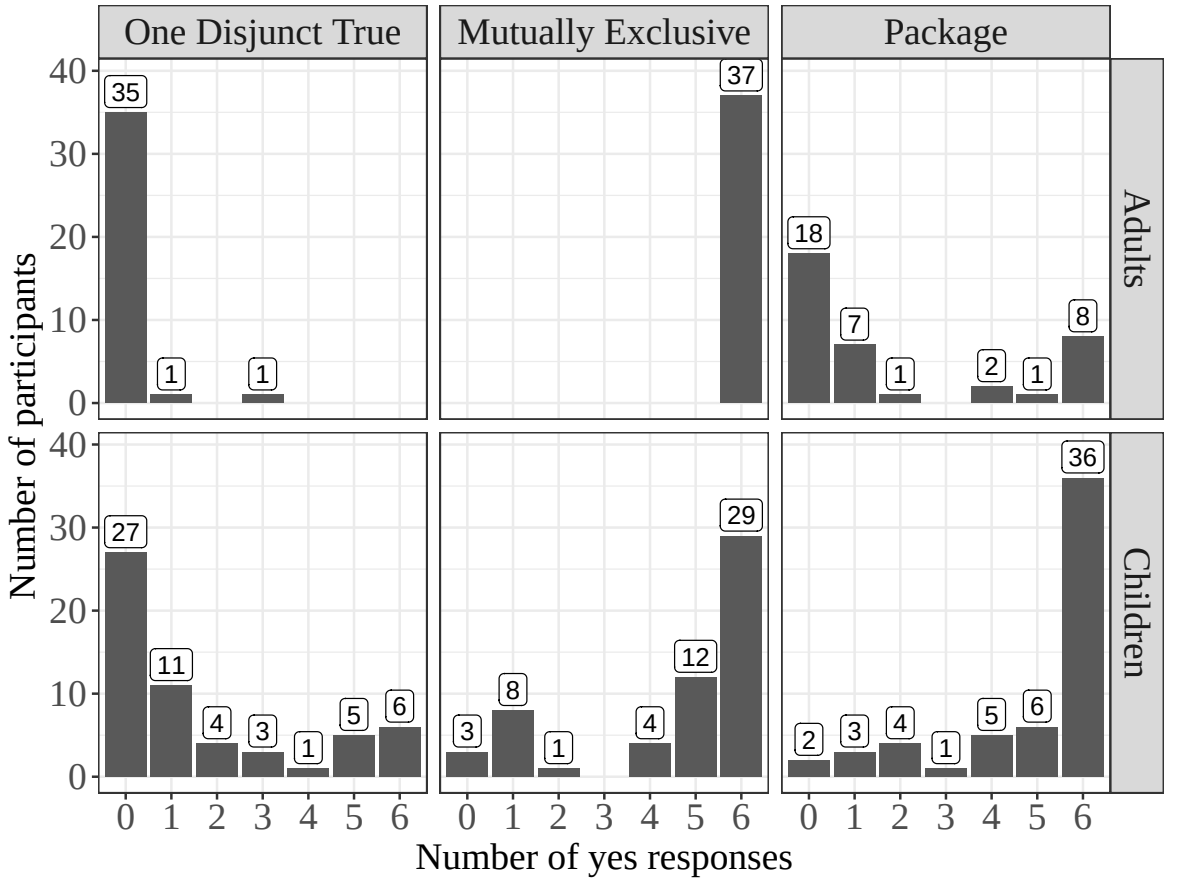


Figure 6: Distribution of the number of participants with different consistency values across conditions for both adults and children.

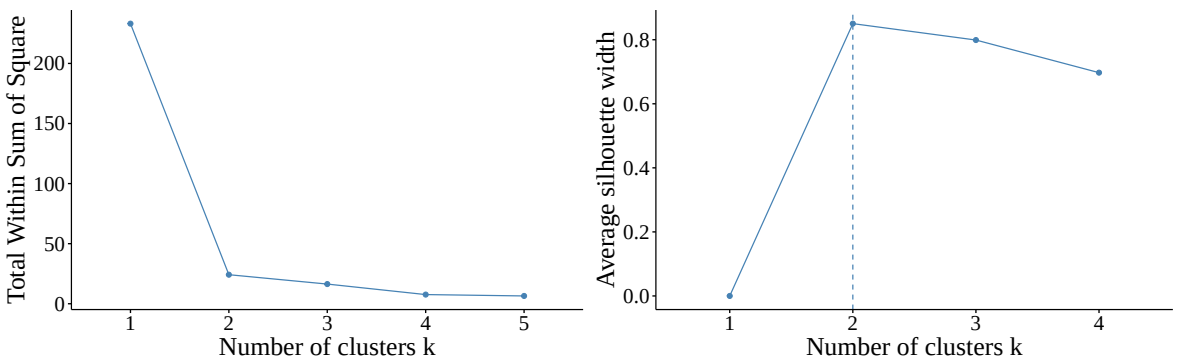
condition, while the others consistently accepted it. Most children showed a similar tendency for the first two conditions. Nevertheless, it clearly appeared that a subset of children accepted the *One Disjunct True* condition, and moreover, a subset rejected the *Mutually Exclusive* condition. This split mostly disappeared for the *Package* condition with the vast majority of children accepting it with the notable exception of a few children who consistently rejected it.

To identify interpretative patterns, a clustering analysis was performed for both the adults and the children groups separately.[18] The *cluster* (Maechler et al., 2025) and *factoextra* packages (Kassambara & Mundt, 2020) were used to define and visualise the optimal number of clusters in the dataset. Finally, a k-means algorithm (MacQueen, 1967) was used to identify clusters, iterated 500 times to ensure the robustness of the output. The results for adults and the children are reported in Sections 6.2.2 and 6.2.3, respectively.

[18] Contrary to Cochard et al. (2025), we did not use a numerical criterion to classify children, e.g. at least 5 yes-answers out of 6 items to be considered as an "accepter" and at most 1 yes-answers out of 6 items to be considered as a "rejecter". The reason is that we wanted to look here at three conditions at the same time. If we were too strict on the three conditions, we would have potentially classified some children as "chance" performers on the sole reason that they did not perform consistently in one condition. For instance, under Cochard et al.'s (2025) criterion, if a child successfully rejected the *One Disjunct True* condition (at most 1 yes answers out of 6 items), accepted the *Mutually Exclusive* condition (at least 5 yes answers out of 6 items) but only sometimes accepted the *Package* condition (e.g. 4 yes answers out of 6 items), then this child would have been considered to be a "chance" performer. However, such a hypothetical child would actually derive the free choice inference and appears to struggle with the exclusivity inference. A clustering approach approach allows more flexibility in that regard, avoiding the premature exclusion of such a child.

6.2.2 Adult cluster analysis

The optimal number of clusters was determined by visualising the within-cluster sum of squares (WCSS) and using the heuristic elbow method. The "elbow" represents the cut-off point where increasing the number of clusters no longer significantly decrease the WCSS value, which typically appears as an angle in the curve. From the elbow curve in Figure 7a it is clear that two is the optimal number of clusters in the adult dataset. This number was double checked by computing a silhouette score to evaluate the clustering quality 7b. This measures how distant a data point is from its own cluster in comparison to the other clusters. The higher the score is, the better is the clustering algorithm. Again, two appears to be the right number of clusters for the adult dataset.



(a) Elbow curve (WCSS) **(b)** Silhouette score

Figure 7: Optimal number of clusters for the adult group.

An anomaly detection algorithm was run to identify any data points whose value was too far away from the centre mean of the cluster, namely, outliers).[19] The centre means of the two clusters are reported in Table 9, before and after it underwent the anomaly detection algorithm. In our dataset, outliers turned out to be participants who were suspected to be at-chance on one of the three conditions (e.g. accepting the *One Disjunct True* condition 3 times out of 6) or isolated participants showing unexpected response patterns.

Cluster	Mean for each condition			Number of participants	
	One Disjunct True	Mutually Exclusive	Package	With outliers	Without outliers
Free Choice without Exclusivity	0.09	6.00	5.54	11	11
Free Choice with Exclusivity	0.11	6.00	0.34	26	25

Table 9: Clusters in the adult dataset.

In Table 9, the only condition that differentiates the two adult clusters is the *Package*

[19] Outliers are data points that appear to be inconsistent with the rest of the data. For instance, in a scatter plot, outliers would be settled far away from their neighbourhood. In this study, outliers were detected using a distance-based approach (Angiulli et al. 2009; Knorr and Ng 1998; Orair et al. 2010; Ramaswamy et al. 2000; see Vinces et al. 2025 for a recent review of clustering based outlier detection techniques). To this effect, a threshold was computationally defined (*[maximum distance − minimum distance] / 2*; Barai (Deb) and Dey 2017). Every data point whose distance from the centre of its cluster was above the threshold was considered as an outlier.

condition. The first and smaller cluster corresponds to the *Free Choice without Exclusivity* response pattern, while the second and larger cluster corresponds to the *Free Choice with Exclusivity* pattern of interpretation. The distribution of the two clusters is illustrated in Figure 8.

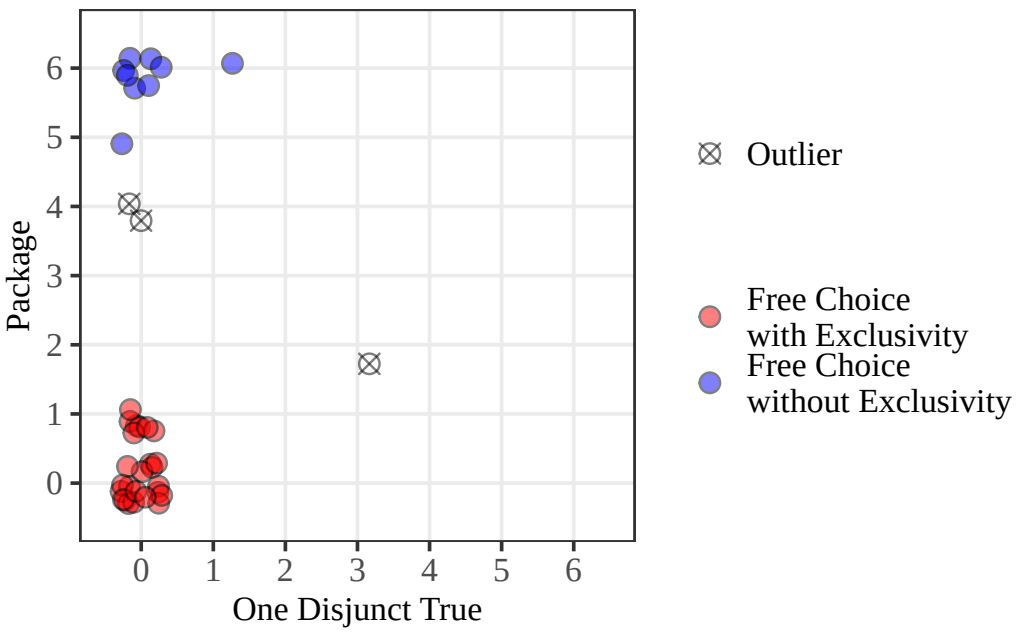
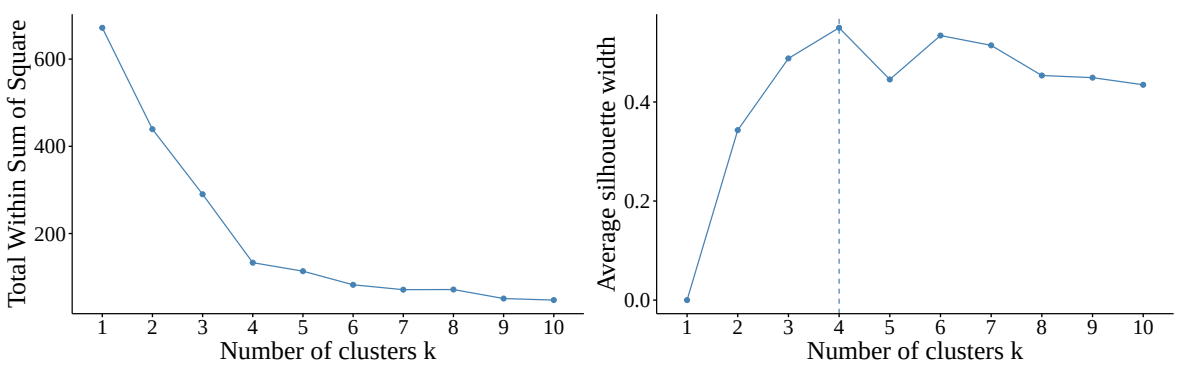


Figure 8: Scatter plot representing the two adult clusters. The *Mutually Exclusive* Condition is not represented since adults all accepted this condition. Jitter added to ease visualisation.

6.2.3 Child cluster analysis

The optimal number of clusters was determined using the same method as for adults. The elbow curve and the silhouette score are given in Figures 9a and 9b, respectively. Here, both figures show that four is the optimal number of clusters. The centre means of the clusters are reported in Table 10.



(a) Elbow curve (WCSS) **(b)** Silhouette score

Figure 9: Optimal number of clusters for the child group.

In the first cluster, 10 participants consistently rejected the *One Disjunct True* and the *Mutually Exclusive* conditions, but accepted the *Package* condition. This pattern corresponds to the *Modal Conjunctive* interpretation (Table 2, fifth row). In the second cluster, participants consistently accepted all conditions, which matches the *Modal Inclusive* interpretive pattern

(Table 2, fourth row). In the third cluster, participants accepted the *Mutually Exclusive* and rejected every other condition. This corresponds to the *Free Choice with Exclusivity* interpretive pattern (Table 2, first row). Finally, in the fourth cluster, participants rejected the *One Disjunct True* and accepted the other conditions, which corresponds to the *Free Choice without Exclusivity* pattern of interpretation (Table 2, second row). The distribution of the four clusters is illustrated in Figure 10.[20]

Cluster	Mean for each condition			Number of participants	
	One Disjunct True	Mutually Exclusive	Package	With outliers	Without outliers
Modal Conjunctive	0.25	0.83	4.75	12	10
Modal Inclusive	4.93	5.86	5.20	15	10
Free Choice with Exclusivity	0.50	5.33	1.16	6	4
Free Choice without Exclusivity	0.54	5.41	5.75	24	22

Table 10: Clusters in the child dataset.

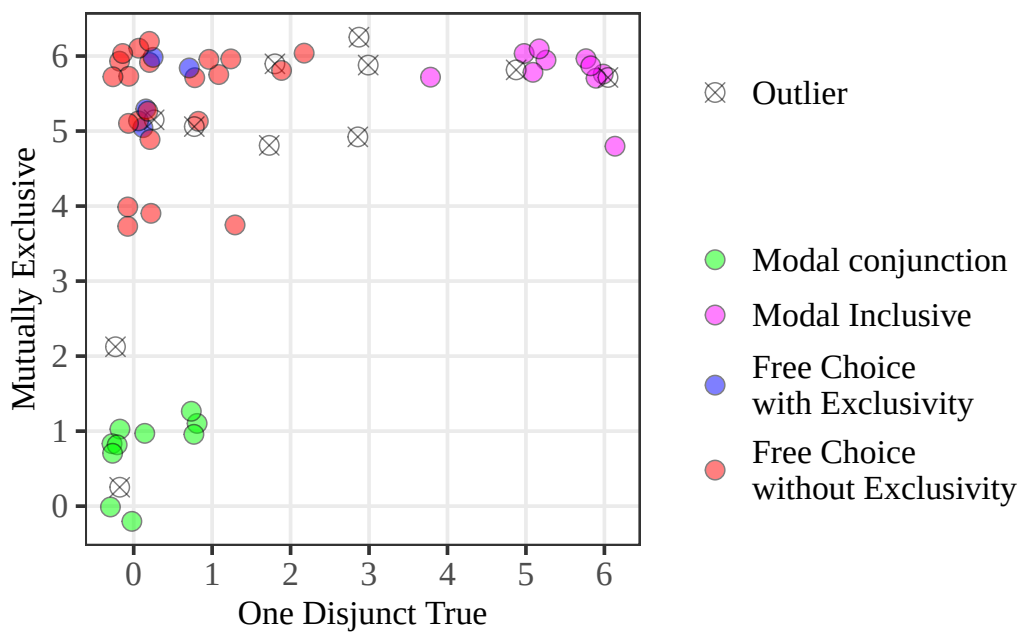


Figure 10: Scatter plot representing the four children clusters. Jitter added to ease visualisation.

An ANOVA comparing two mixed-effects models revealed that including an interaction between age and cluster membership did not improve model fit ($\chi^2(3) = 2.38; p = 0.497$). This suggests that the distribution of children across clusters is independent of age.

Table 11 summarises the numbers of adults and children participants per identified pattern.

[20] Note that the *Free Choice with Exclusivity* group and its *Free Choice without Exclusivity* counterpart overlap in Figure 10, as they differ only in their responses to the *Package* condition, which is not plotted here.In a similar manner, outliers overlapping with consistent participants were outliers specifically on the *Package* condition.

While all adults derived a free choice inference, by far not all children did so. Roughly half of the children (n = 26/46; 56%) derived a free choice inference, while the other half (n = 20/46; 44%) showed either a *Modal Conjunctive* interpretation or a *Modal Inclusive* interpretation, giving instead the Modal Inclusive meaning of modal disjunction. Among the free choice interpreters (n = 26), children differed from adults by almost never deriving the additional exclusivity inference: while the majority of adults derived the exclusivity inference (n = 25/36; 69%), only a fraction of the children did so (n = 4/36; 8%).

Interpretation	Status	Adults	Children
Free Choice with Exclusivity	Target	69% (25/36)	8% (04/46)
Free Choice without Exclusivity	Target	31% (11/36)	48% (22/46)
Modal Conjunction	Non-target	0% (0/36)	22% (10/46)
Modal Inclusive	Non-target	0% (0/36)	22% (10/46)

Table 11: Ratio (and numbers) of adult and children participants per individual pattern; 1 adult outlier and 11 children outliers were not included in this table.

6.3 Justifications

Occasionally, justifications were collected[21] to assess whether the children's response reflected an actual interpretative pattern or if they just misunderstood the condition. We identified two main strategies in justifying yes and no responses. First, some children referred directly to the visual setup, either by pointing at the number of coins or by mentioning which of the two disjuncts can be bought (48). Second, other children referred to the test sentence itself, either by repeating what the shop employee said as in (49) or by paraphrasing their interpretation of the test sentence as in (50).

(48) **Reject *One Disjunct True*** (Ch.832615.Modal.Conjunctive)
Non parce qu'il a pas 3 pièces. Il peut pas acheter les
No because that.he AUX.3SG.PRS NEG 3 coins he can.3SG.PRS NEG buy.INF the
deux.
both
"No, because he does not have 3 coins. He cannot buy both".

(49) **Accept *Mutually Exclusive*** (Ch.771039.Modal.Inclusive)
Il a dit qu'on pouvait acheter la pastèque
he aux.3SG.PRS say.PART.PST that.PRO.INDF can.3SG.IMPF.PST buy.INF the watermelon
ou l'abricot.
or the.apricot
"He said that we can buy the watermelon or the apricot".

(50) **Reject *Package*** (Ch.350610.Free.choice.Excl)
il a dit qu'on peut pas prendre les deux.
he AUX.3SG.PRS say.PART.PST that.PRO.INDF can.3SG.PRS neg take.INF the both
He said that we cannot take both.

[21] For authorization purposes with the parents, the experiment could not be audio or video recorded. Justifications were collected by hand, on the fly. Furthermore, it was not possible to ask for justifications for every item as the time to complete the experiment would have exceeded the allowed time per child in the school.

Interestingly, in their justifications, several children used alternative coordinators such as *et* "and" (51) or part of the exclusive disjunctive expression *soit...soit...* "either...or..." (52), although the latter was rarer.

(51) **Accept *One Disjunct True*** (Ch.771039.Modal.Inclusive)
Il a pas dit "et".
he AUX.3SG.PRS neg say.PART.PST and
He did not say "and".

(52) **Accept *Mutually Exclusive*** (Ch.243731)
Il peut acheter un yaourt soit un gâteau
he can.3SG.PRS buy.INF a yoghurt SOIT a cake
He can buy either a yoghurt or a cake.

(53) **Reject *Mutually Exclusive*** (Ch.832615.Modal.Conjunctive)
[non] il a dit qu'on pouvait acheter les deux.
no he AUX.3SG.PRS say.PART.PST that.PRO.INDF can.3SG.IMPF.PST buy.INF the both
No, he said that we can buy both.

7 Discussion

This section discusses the results and proposes a novel explanation for the *Modal Conjunctive* interpretation of modal disjunction framed within the grammatical approach to scalar implicatures. Specifically, Section 7.1 summarises the main findings, distinguishing adult-like and non-adult patterns in Section 7.1.1 and 7.1.2, respectively. In Section 7.2, we develop an account of the *Modal Conjunctive* interpretations by entertaining two crucial components: a conjunctive-less set of alternatives and a local pragmatic enrichment procedure. In Section 7.3, we further explore the interplay between the two components introduced earlier and in Section 7.4 we present two possible explanations for why some children would prefer to exhaustify locally. Finally, in Section 7.5, we spell out predictions from our account about the developmental trajectory and the consequences for other disjunctive environments.

7.1 Main findings

The goal of this study was to investigate the interpretation of modal disjunctive statements in child language, putting to the test the earlier claims that 4- to 6-year-old children have acquired the associated free choice inference at adult-like rates. Specifically, we tested an alternative proposal about the learner's developing grammar that allegedly adult-like children might instead be *Modal Conjunctive* interpreters, and, furthermore, we investigated whether children draw the additional exclusivity inference. To achieve these goals, we developed an innovative design that included two new conditions. The first one was the *Mutually Exclusive* condition which allowed us to tease apart an (adult-like) free choice interpretation from a (non-adult-like) modal conjunction interpretation that previous experimental designs could not distinguish. The results showed that some children were indeed *Modal Conjunctive* interpreters. Using the *Mutually Exclusive* scenario thus proved essential in identifying a non-adult-like subgroup of children who gave a *Modal Conjunctive* interpretation of modal disjunctive statements. The second novel condition, the *Package* condition, focused on the exclusivity inference. It was found that there were two sub-groups among adults as well as among children, suggesting that this inference is optional in the target grammar, though the most common interpretation differed between adults and children. The individual-level analyses established two distinct

adult interpretations (*Free Choice with Exclusivity* and *Free Choice without Exclusivity*) and two non-adult-like interpretations (*Modal Conjunctive* and *Modal Inclusive*; see Table 11).

7.1.1 Adult-like interpretations: *Free Choice with Exclusivity* and *Free Choice without Exclusivity*

Starting with the adult-like patterns, only half of the 4 to 6-year-olds (56%) computed a free choice inference in an adult-like way, successfully rejecting the *One Disjunct True* condition and accepting the *Mutually Exclusive* condition. Prior studies reported near-ceiling performance in the computation of the free choice inference. For instance, rejection rates of a condition falsifying free choice reached 95% in Huang and Crain (2020) and 91% in Zhou et al. (2013) and Tieu et al. (2016). Our findings suggest, however, that the interpretation of these high rates may not be fully correct, as only about half of the children derived this inference in our study. This suggests that the free choice inference is not acquired as early as previously argued.

Furthermore, adding the *Package* condition to the discussion allows us to investigate the question whether the children who derived the free choice inference in our study, can be considered fully adult-like. While a majority of adults rejected the *Package* condition, deriving the exclusivity inference (69%), only a small proportion of the children who calculated the free choice inference (15%) also derived this optional inference. In contrast, the largest group of children (85%) accepted the *Package* condition, showing no evidence of exclusivity. This raises two questions: first, why did not all adults derive this inference? This behaviour is expected under Simons (2005) who claims that this inference is optional. However, under Fox's exhaustification approach (Fox, 2007), this inference is predicted to automatically arise before the free choice inference. A clear-cut answer is that this inference can simply be cancelled, like regular scalar implicatures. Moreover, as discussed by Fox and Katzir (2011), it is also possible that the conjunctive alternative is not made relevant in the context for some speakers, and as such not included in the set of alternatives under consideration for the pragmatic enrichment procedure.[22] Second, why does only a minority of children derive the exclusivity inference? In Section 7.1.2, we suggest that some of these children may not be able to derive this inference in the first place.

7.1.2 Non-adult-like interpretations: *Modal Conjunctive* and *Modal Inclusive*

Turning now to the non-adult-like patterns, 10 children (22%) consistently gave a *Modal Conjunctive* interpretation, rejecting both the *One Disjunct True* and the *Mutually Exclusive* conditions. This interpretive pattern, which was the focus of the present study, constitutes a novel finding and has several critical implications. From a methodological perspective, it shows that, without the inclusion of a *Mutually Exclusive* scenario, these *Modal Conjunctive* children might have been misclassified as adult-like interpreters of modal disjunctive statements. This means that such a condition should be included in future studies to reveal children's real pragmatic abilities with disjunction. Empirically, the finding that some children assign a *conjunctive* interpretation to disjunction in modal contexts shows that this phenomenon extends beyond constructions with simple disjunction (cf. Singh et al. 2016), as hypothesised in Section 3 (36) and repeated below in (54).

[22] These two options cannot be distinguished in our study. A solution would be to examine the processing cost of the additional exclusivity inference, assuming that processing implicatures that require alternatives obtained via scalar replacement are cognitively heavier than implicatures that do not (Chemla & Bott, 2014). If the exclusivity inference has been cancelled, a trace of the formerly derived implicature should be detected, e.g. via online measures such as eye-tracking and response times. Conversely, if the scalar alternative was never present, then no processing cost should be detected. We leave it to future studies to check and elaborate on this hypothesis, as well as how to test it with both children and adults.

(54) **Extending conjunctive interpretations to modal disjunction:**
a. Since $(P \vee Q)$ is interpreted as $(P \wedge Q)$
b. Then it is plausible that $\Diamond(P \vee Q)$ is interpreted as $\Diamond(P \wedge Q)$

Most importantly, the subgroup of non-adult-like *Modal Conjunctive* interpreters demonstrates that free choice inferences are not fully acquired by age 4 to 6, contrary to the conclusions from previous studies (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020). This further implies that these children do not engage in adult-like pragmatic enrichment, which we have framed within the grammatical approach to scalar implicatures outlined in Section 2. Moreover, Bleotu et al. (2024b), adapting our *Mutually Exclusive* and *Package* conditions in their own experimental design, also reported *Modal Conjunctive* interpretations in child Romanian (mean age = 5;5), confirming the new empirical generalisation that children can assign a conjunctive interpretation to modal disjunctive statements.

A second non-adult-like pattern observed in the children revealed the absence of pragmatic enrichment. This subgroup (22%) derived neither the free choice inference nor the exclusivity inference, accepting both the *One Disjunct True* and the *Mutually Exclusive* conditions. These *Modal Inclusive* children constitute another novel finding in the acquisition of modal disjunction. In particular, it echoes results from earlier studies on simple disjunction, where a subset of participants likewise failed to compute any inference, not deriving exclusivity and instead interpreting the disjunctive statement inclusively (Boster & Crain, 1993; Chierchia et al., 2001b, 2001a; Singh et al., 2016; Tieu et al., 2017; Cochard et al., 2023; Sauerland & Yatsushiro, 2018; Pagliarini et al., 2018a; Goro et al., 2006; Huang & Crain, 2020; Su, 2014; Su & Crain, 2010; Bleotu et al., 2023).

The existence of a subgroup of *Modal Conjunctive* children raises questions about their grammar at this developmental stage: what precisely is not yet acquired? This issue is taken up in the following subsections. In Section 7.2, we put forward a novel explanation: children are capable of exhaustifying modal disjunctive statements, but they do so in a way that diverges from the adult grammar, lacking the conjunctive alternative and inserting the *Exh* operator locally in the structure.

7.2 Accounting for *Modal Conjunctive* children

This section outlines our explanation for children's *Modal Conjunctive* interpretations of modal disjunctive statements. Before turning to the analysis, Section 7.2.1 considers the possibility that *Modal Conjunctive* children confuse the disjunctive connective with the conjunctive one, and explains why this is unlikely. Section 7.2.2 then discusses two ingredients of the pragmatic enrichment procedure that together can lead to a *Modal Conjunctive* interpretation. Specifically, we argue that *Modal Conjunctive* children lack the conjunctive scalar alternative from the set of alternatives under consideration, following Singh et al.'s (2016) account for conjunctive interpretations of simple disjunction. We furthermore introduce a novel ingredient not considered before in the acquisition of the free choice inference: the locus of pragmatic enrichment.[23] In particular, we show that if pragmatic enrichment applies locally, and if the conjunctive alternative is absent, a *Modal Conjunctive* interpretation is naturally derived.

7.2.1 Is there a lexical confusion between disjunction and conjunction?

An often suggested explanation to account for a *Modal Conjunctive* interpretation is to say that

[23] This option was also considered by Singh et al. (2016) to explain how children arrive at the conjunctive interpretation of disjunction when the disjunctive statement is embedded under the universal quantifier *every*.

there is a lexical confusion between the disjunctive word and the conjunctive one: children would simply mistake the disjunctive word *ou* "or" for the conjunctive one *et* "and" and no pragmatic enrichment would be involved. Although this explanation cannot be definitly ruled out by the present study, it appears rather unlikely given that children clearly distinguished disjunction from conjunction in certain non-modal environments. For instance, several studies investigated how children interpret disjunction in downward-entailing contexts such as the antecedent of conditionals or in the nuclear scope of *before* or *not every* (Su, 2014; Su & Crain, 2010; Notley et al., 2012). As pragmatic enrichment is generally not expected in such environments,[24] disjunction should be interpreted inclusively, a meaning critically distinct from the meaning of conjunction. For example, in conditional sentences, (55), the consequent is true in three possible scenarios in (55a) to (55c) when the antecedent contains disjunction, but only in one scenario when the antecedent contains conjunction (56). If children truly confused disjunction with conjunction, they would have been expected to accept the consequent as true in only one scenario. Yet, Su and Crain (2010) demonstrated that this was not the case, concluding that children do not confuse the two connectives.

(55) If Liz buys a croissant or a donut, Sandra will be happy. $(P \vee Q) \Rightarrow R$
   a. ✓ Liz bought a croissant, Sandra is happy.
   b. ✓ Liz bought a donut, Sandra is happy.
   c. ✓ Liz bought a croissant and a donut, Sandra is happy.

(56) If Liz buys a croissant and a donut, Sandra will be happy. $(P \wedge Q) \Rightarrow R$
   a. × Liz bought a croissant, Sandra is happy.
   b. × Liz bought a donut, Sandra is happy.
   c. ✓ Liz bought a croissant and a donut, Sandra is happy.

Although this constitutes only indirect evidence against a lexical confusion account of *Modal Conjunctive* interpretations, we leave these issues open for further investigation. For the purposes of the explanation developed in the next section, however, we assume that children do not mistake one connective for the other.

7.2.2 Deriving the *Modal Conjunctive* interpretation

To derive a *Modal Conjunctive* interpretation, we propose that children pragmatically enrich modal disjunctive statements. However, their reasoning departs from the adult grammar in two key ways. First, children have not yet acquired the full set of alternatives against which modal disjunction is evaluated. Extending Singh et al.'s (2016) account of the conjunctive reading of simple disjunction, we argue that the child set of alternatives does not include the scalar modal conjunctive alternative. Second, in these learners' grammars, the exhaustification procedure applies locally, precisely, below the modal operator. This section explains and illustrates these two components, showing how they jointly account for children's *Modal Conjunctive* interpretations.

To account for conjunctive interpretations of simple disjunction, Singh et al. (2016) proposed that children are capable of pragmatically enriching disjunctive statements but differ from adults in their access to alternatives. Specifically, they argue that while children can generate alternatives that require only replacement by sub-constituents (see (8) in Section 2),

[24] Scalar implicatures typically strengthen the weaker meaning of a term to a stronger one (e.g., "P or Q" $\rightsquigarrow$ "(P or Q) and not (P and Q)"). However, in downward-entailing contexts, the entailment direction is reversed: a logically weaker expression entails a stronger one. As a result, enriching the weaker term (via implicature) would make incorrect predictions and eventually weaken the output meaning.

namely the individual disjuncts, they do not perform the lexical replacement of disjunction with conjunction. As a result, whereas the adult set of alternatives includes the scalar alternative in (57a), the child's set of alternatives lacks it (57b). This restricted set of alternatives leads to conjunctive strengthening of simple disjunction, yielding an interpretation equivalent to conjunction and, crucially, mirroring the derivational process behind free choice inferences (see Section 2; see also Chapter 2 for the full derivation).

(57) a. **Adult set of alternatives for** $(P \vee Q)$**:**
$ALT(P \vee Q) = \{\underbrace{(P \vee Q)}_{\text{Prejacent}}, \underbrace{P \ , \ Q}_{\text{Individual disjuncts}}, \underbrace{(P \wedge Q)}_{\text{Conjunctive alternative}}\}$

b. **Child set of alternatives for** $(P \vee Q)$**:** (Singh et al., 2016)
$ALT_{\text{CHILD}}(P \vee Q) = \{\underbrace{(P \vee Q)}_{\text{Prejacent}}, \underbrace{P \ , \ Q}_{\text{Individual disjuncts}}\}$

Extending this claim straightforwardly to the modal context, we propose that (a subset of the) children do not generate the scalar alternative *and* for *or* in modal disjunctive statements either. More specifically, whereas the adult set of alternatives in (58a) includes the prejacent $(\Diamond[P \vee Q])$ in addition to the individual disjuncts $(\Diamond P, \Diamond Q)$ and the conjunctive alternative $(\Diamond[C \wedge D])$, the corresponding set for children in (58b) mirrors that of (57b), containing only the prejacent and the individual disjuncts, thus lacking the conjunctive alternative.

(58) a. **Adult set of alternatives for** $\Diamond(P \vee Q)$**:**
$ALT(\Diamond[P \vee Q]) = \{\underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}}, \underbrace{\Diamond P \ , \ \Diamond Q}_{\text{Individual disjuncts}}, \underbrace{\Diamond(P \wedge Q)}_{\text{Conjunctive alternative}}\}$

b. **Child set of alternatives for** $\Diamond(P \vee Q)$**:**
$ALT_{\text{CHILD}}(\Diamond[P \vee Q]) = \{\underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}}, \underbrace{\Diamond P \ , \ \Diamond Q}_{\text{Individual disjuncts}}\}$

However, the absence of the conjunctive alternative from the set of exploitable alternatives is not, by itself, sufficient to generate a *Modal Conjunctive* interpretation. To illustrate this, consider the derivation in (59) to (62). Given the set of alternatives in (59a) lacking the conjunctive alternative and the resulting empty set of innocently excludable alternatives in (59b), the first round of exhaustification yields no strengthened meaning, as shown in (60). Recall that the superscript plus sign indicates that the statement already underwent a round of exhaustification, though a vacuous one here.

(59) **Sets of alternatives for the first round of exhaustification:**

a. Conjunctive-less set of alternatives:
$ALT_{\text{CHILD}}(\Diamond[P \vee Q]) = \{\Diamond(P \vee Q), \Diamond P, \Diamond Q\}$

b. Set of Innocently Excludable alternatives:
$ALT^{\text{IE}}_{\text{CHILD}}(\Diamond[P \vee Q]) = \{\Diamond P\} \cap \{\Diamond Q\}$
$= \varnothing$

(60) **First round of exhaustification:**

$$Exh(ALT_{\text{CHILD}}(\Diamond[P \vee Q]))(\Diamond[P \vee Q]) \Leftrightarrow \underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg ALT^{\text{IE}}_{\text{CHILD}}(\Diamond[P \vee Q])}_{\text{Negating IE Alternatives}}$$

$$\Leftrightarrow \underbrace{\Diamond(P \vee Q)^{+}}_{\text{Prejacent}}$$

As a consequence, the sentence still carries ignorance, thereby allowing for a second round of exhaustification in accordance with the *Exh* parsing strategy outlined in (12; Fox 2007). For this second round, the set of alternatives is structurally identical to the one that enables the derivation of the free choice inference, except that it lacks the scalar conjunctive alternative (61). Crucially, the absence of this alternative prevents the derivation of the optional exclusivity inference. This omission is essential, as the presence of an exclusivity inference would conflict with the intended *Modal Conjunctive* interpretation. The derivation for the second round is provided in (62).

(61) **Sets of alternatives for the second round of exhaustification:**

a. Conjunctive-less set of alternatives:

$$ALT(\Diamond[P \vee Q]^{+}) = \{Exh(\Diamond[P \vee Q]), Exh(\Diamond P), Exh(\Diamond Q)\}$$
$$= \{\Diamond(P \vee Q), (\Diamond P \wedge \neg\Diamond Q), (\Diamond Q \wedge \neg\Diamond P)\}$$

b. Set of Innocently Excludable alternatives:

$$ALT^{\text{IE}}(\Diamond[P \vee Q]^{+}) = \{(\Diamond P \wedge \neg\Diamond Q), (\Diamond Q \wedge \neg\Diamond P)\}$$

(62) **Second round of exhaustification:**

a. $Exh(ALT(\Diamond[P \vee Q]^{+}))(\Diamond[P \vee Q]^{+})$

b. (62a) $\Leftrightarrow \underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg ALT^{\text{IE}}(\Diamond[P \vee Q]^{+})}_{\text{Negating IE Alternatives}}$

$$\Leftrightarrow \underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(\Diamond P \wedge \neg\Diamond Q)}_{\text{Not only possible P}} \wedge \underbrace{\neg(\Diamond Q \wedge \neg\Diamond P)}_{\text{Not only possible Q}}$$

$$\Leftrightarrow \underbrace{\Diamond(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{(\Diamond P \leftrightarrow \Diamond Q)}_{\substack{\text{Both possibilities} \\ \text{or neither}}}$$

$$\Leftrightarrow \underbrace{\Diamond P \wedge \Diamond Q}_{\text{Free Choice}}$$

All in all, strengthening a modal disjunctive statement with respect to a set of alternatives lacking the conjunctive alternative yields the free choice inference, but not the exclusivity inference. However, a *Modal Conjunctive* interpretation is not derivable at this stage, and an additional assumption is required.

The second ingredient for our account of the *Modal Conjunctive* reading in children is the locus of the exhaustification procedure. In the course of meaning composition in the adult grammar, the *Exh* operator may apply globally, taking scope over the entire statement, or locally, scoping over a sub-constituent within the statement. Notice that, while the *Exh* parsing strategy given in (12) is formulated as if it only applies to complete sentences, it is relatively uncontroversial that *Exh* can also be appended to sub-constituents. We demonstrate below that a *Modal Conjunctive* interpretation arises when pragmatic enrichment is applied locally, in

conjunction with the other non-adult-like element in children's grammar, namely the absence of the scalar conjunctive alternative from the set of alternatives under consideration. In the case of global exhaustification, the *Exh* operator scopes over the full modal disjunctive statement, as in (63a), which corresponds to the adult-like derivation of the free choice inference. In contrast, in the case of local exhaustification, the *Exh* operator is inserted between the modal and the disjunctive phrase, as illustrated in (63b).[25] [26]

(63) a. Global exhaustification: $Exh(Exh(\Diamond(P \vee Q)))$ Target
b. Local exhaustification: $\Diamond(Exh(Exh(P \vee Q)))$ Non-target

With local exhaustification, the *Modal Conjunctive* interpretation follows straightforwardly, as illustrated in the derivation in (64) to (67). By having the enrichment procedure target the disjunctive sub-constituent, the set of alternatives involved in the first round of exhaustification now mirrors the set of alternatives provided in (64a). Given that the set of innocently excludable alternatives is empty (64b), the initial application of the local exhaustification procedure is vacuous, as demonstrated in (65). The output meaning has not changed but enriched alternatives are now available.

(64) **Sets of alternatives for the first round of exhaustification:**
a. Conjunctive-less set of alternatives:
$ALT_{\text{CHILD}}(P \vee Q) = \{(P \vee Q), P, Q\}$
b. Set of Innocently Excludable alternatives:
$ALT^{\text{IE}}_{\text{CHILD}}(P \vee Q) = \{P\} \cap \{Q\}$
$= \varnothing$

(65) **First round of exhaustification:**

$$\Diamond[Exh(ALT_{\text{CHILD}}(P \vee Q))(P \vee Q)] \Leftrightarrow \Diamond[\underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg ALT^{\text{IE}}_{\text{CHILD}}(P \vee Q)}_{\text{Negating IE Alternatives}}]$$

$$\Leftrightarrow \Diamond[\underbrace{(P \vee Q)^{+}}_{\text{Prejacent}}]$$

[25] To allow for the insertion of the *Exh* operator at a local level, Fox (2007) updated the *Exh* parsing strategy in (i), which explicitly allows *Exh* to be inserted in embedded position.

(i) **Exh parsing strategy (updated):** (Fox, 2007; fn. 37)
If a sentence S has an undesirable Ignorance Inference, try to append *Exh* to some constituent X in S. I.e., modify the parse $[S \ldots X \ldots]$ as follows: $[S \ldots Exh(ALT[X])(X) \ldots]$.

[26] Evidence of local calculation of scalar implicatures in adults is provided by Chierchia (2004) in (i). Here, the interpretation in (ia) naturally arises by negating the universal alternative in (iia). Importantly, this alternative is only accessible if the implicature procedure is local, at the level of the second disjunct of (i). If the implicature procedure was global, taking scope above the whole statement, (i) would have received (iib) as an alternative. However, negating (iib) would have resulted in the interpretation in (ib), which is blatantly wrong as the first disjunct is negated as well.

(i) Mary is either working at her paper or seeing some of her students.
a. ✓ **Local implicature:**
Mary is either working at her paper or seeing some (but not all) of her students.
b. ✕ **Global implicature:**
Mary is not working at her paper (and she is seeing some but not all of her students).
(ii) a. Mary is seeing all of her students.
b. Mary is either working at her paper or seeing all of her students.

Since ignorance has not been resolved in the first round, the *Exh* parsing strategy applies a second time, initiating a new round of exhaustification. In this round, the set of innocently excludable alternatives is non-empty, populated by the enriched alternatives derived during the first application of *Exh*, (66). Negating these alternatives (through exhaustification) yields a conjunctive interpretation, analogous to the conjunctive strengthening observed for simple disjunction. Because the modal operator now takes scope over this exhaustified, conjunctive statement, the resulting interpretation corresponds to modal conjunction, as shown in (67).

(66) **Sets of alternatives for the second round of exhaustification:**

a. Conjunctive-less set of alternatives:
$$\begin{aligned} ALT(P \vee Q)^{+} &= \{Exh(P \vee Q), Exh(P), Exh(Q)\} \\ &= \{(P \vee Q), (P \wedge \neg Q), (Q \wedge \neg P)\} \end{aligned}$$

b. Set of Innocently Excludable alternatives:
$ALT^{\text{IE}}(P \vee Q)^{+} = \{(P \wedge \neg Q), (Q \wedge \neg P)\}$

(67) **Second round of exhaustification:**

$$\begin{aligned} \Diamond[Exh(ALT(P \vee Q)^{+})(P \vee Q)^{+}] &\Leftrightarrow \Diamond[\underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg ALT^{\text{IE}}(P \vee Q)^{+}}_{\text{Negating IE Alternatives}}] \\ &\Leftrightarrow \Diamond[\underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(P \wedge \neg Q)}_{\text{Not only P}} \wedge \underbrace{\neg(Q \wedge \neg P)}_{\text{Not only Q}}] \\ &\Leftrightarrow \Diamond[\underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{(P \leftrightarrow Q)}_{\substack{\text{Both true or} \\ \text{both false}}}] \\ &\Leftrightarrow \underbrace{\Diamond(P \wedge Q)}_{\substack{\text{Modal} \\ \text{Conjunction}}} \end{aligned}$$

Importantly, under local derivation account, no modifications are posited to the semantics of the modal, the disjunction, or the exhaustification procedure itself. The only changes concerns the nature of the set of relevant alternatives and the locus of pragmatic enrichment, extending Singh et al.'s (2016) analysis of children's conjunctive interpretation of simple disjunction and of disjunction embedded under *every* to the case of modal disjunction. Importantly, While Singh et al. (2016) also appealed to local pragmatic enrichment to explain conjunctive interpretations of disjunction under *every*, they did not envisage that this could be a critical variable in shaping the interpretation of modal disjunction. Instead, they assumed that children were adult-like in such contexts, a prediction not supported by our results. In Section 7.3, we explore how different configurations of these two elements predict all attested interpretations in our study. Section 7.4 then addresses why some children perform local pragmatic enrichment, inserting *Exh* low in the syntactic structure. Section 7.5 examines the broader developmental predictions that follow.

7.3 Exploring the interaction between the set of alternatives and the locus of exhaustification

In Section 7.2, we defined two ingredients that together lead to the derivation of the *Modal Conjunctive* interpretation: the nature of the set of alternatives and the locus of pragmatic enrichment. These ingredients introduce two parameters for characterising (non-)adult-

like grammars, illustrated in (68) and (69). In this section, we demonstrate that specific configurations of these parameters can also account for all (non-)adult-like patterns reported in Section 5.

(68) **Nature of the set of alternatives:**
   a. Target: complete set of alternatives:
      – Simple disjunction: $ALT(P \vee Q) = \{(P \vee Q), P, Q, (P \wedge Q)\}$
      – Modal disjunction: $ALT(\Diamond[P \vee Q]) = \{\Diamond(P \vee Q), \Diamond P, \Diamond Q, \Diamond(P \wedge Q)\}$
   b. Non-target: incomplete set of alternatives:
      – Simple disjunction: $ALT_{\text{CHILD}}(P \vee Q) = \{(P \vee Q), P, Q\}$
      – Modal disjunction: $ALT_{\text{CHILD}}(\Diamond[P \vee Q]) = \{\Diamond(P \vee Q), \Diamond P, \Diamond Q\}$

(69) **Locus of the exhaustification procedure:**
   a. Global exhaustification: $Exh > \Diamond(P \vee Q)$
   b. Local exhaustification: $\Diamond > Exh > (P \vee Q)$
   c. No insertion of *Exh*: $\Diamond(P \vee Q)$

First, the scalar alternative parameter in (68) distinguishes two configurations depending on whether the scalar conjunctive alternative is included in the set of alternatives: either it is present (68a) or it is absent (68b). Second, the exhaustification locus parameter in (69) specifies three possibilities: global exhaustification (69a), local exhaustification (69b), or the absence of *Exh* altogether (69c). Note that within each configuration of the scalar alternative parameter (68), we further distinguish between alternatives generated for simple disjunction and those generated for modal disjunction. This distinction depends on the locus of exhaustification: if exhaustification is local, the alternatives relevant to simple disjunction are used, since the modal scopes above the *Exh* operator; if exhaustification is global, the set of alternatives is evaluated with respect to the entire modal disjunctive statement.

The interaction between these two parameters yields five distinct possible grammars. Four of them correspond to the interpretive patterns observed in our data while the fifth one was unattested. These five grammars are summarised in Table 12.

Status	**Grammar**	**Set of alternatives**	***Exh***	**Interpretation**
Target	Free Choice with Exclusivity	Complete	Global	$\Diamond P \wedge \Diamond Q \wedge \neg\Diamond(P \wedge Q)$
	Free Choice without Exclusivity	Incomplete	Global	$\Diamond P \wedge \Diamond Q$
Non-Target	Modal Conjunctive	Incomplete	Local	$\Diamond(P \wedge Q)$
	Modal Inclusive			$\Diamond(P \vee Q)$
Unattested	Only Exclusivity	Complete	Local	$\Diamond[(P \vee Q) \wedge \neg(P \wedge Q)]$

Table 12: Key properties of each grammar regarding the nature of the set of alternatives and the location of the site of exhaustification.

The *Free Choice with Exclusivity* grammar is the well-known expected adult-like grammar, arising from the combination of a full set of alternatives for disjunction and global exhaustification (see Section 2.2 for the derivation).

The *Free Choice without Exclusivity* grammar is ambiguous, as it permits two possible interpretations. In this grammar, the free choice inference is correctly derived, but the exclusivity inference is absent (see first part of Section 7.2 for the derivation). One possibility is that the exclusivity inference was simply cancelled. Alternatively, it may reflect a more subtle grammar, in which pragmatic enrichment applies globally, but the conjunctive alternative, $\Diamond(P \wedge Q)$, is missing from the set of alternatives under consideration, including for adults. This absence could result either from a genuine inability to perform lexical replacement of *or* by *and*, as claimed by Singh et al. (2016), or from the conjunctive alternative not made salient enough in the context to be considered during pragmatic enrichment, as discussed by Fox and Katzir (2011). Importantly, under this latter possibility, the group of non-adult-like children lacking the conjunctive alternative could, in fact, encompass a significantly larger proportion of the tested sample.

The *Modal Conjunctive* is a non-target grammar in which children lack the conjunctive alternative from the set of innocently excludable alternatives and insert the *Exh* operator locally, below the modal. The resulting derivation does not yield a free choice nor an exclusivity inference, but instead produces a *Modal Conjunctive* interpretation, as demonstrated in Section 7.2. This grammar was distinguished from the *Free Choice with Exclusivity* and *Free Choice without Exclusivity* grammars by including the *Mutually Exclusive* condition in the experimental design. In section 7.4, we return to the question of why some children appear to prefer local pragmatic enrichment.

The *Modal Inclusive* non-target grammar corresponds to a grammar without visible pragmatic enrichment. As with the *Free Choice without Exclusivity* grammar, two explanations can account for the absence of any inference. One possibility is that these children did derive the free choice inference (and possibly the exclusivity inference) but subsequently cancelled it. The other is that these children may never have derived any inference in the first place. The second possibility raises the question of whether the absence of visible pragmatic enrichment reflects a preference not to insert the operator (e.g., due to processing costs), or instead a more general inability to produce pragmatically enriched meaning, that is, these children have yet to acquire a pragmatic enrichment mechanism such as the *Exh* operator. Following Heredia Murillo (2023), we consider the latter option less likely and assume that the *Exh* operator is acquired early in language development, since it involves basic notions attested in two- to three-year-old children, such as reasoning over logical space (Mody, 2016; Cesana-Arlotti & Halberda, 2024; among many others) and knowledge of the core concept of negation (Reuter et al., 2018; de Carvalho & Dautriche, 2025; among many others).

With respect to the absence of inference in simple disjunction and in disjunction under *every*, Singh et al. (2016) write that "'*Logicians'* [i.e., children showing no inference]*are those individuals – child or adult – who choose to not exhaustify*". Their phrasing suggests that such children have the ability to produce pragmatically enriched meanings but did not deploy it, for reasons they left unexplored. Crucially, however, for Singh et al. (2016), the absence of any inference is a valid adult-like strategy. For modal disjunctive statements, by contrast, this strategy is non-adult-like, since all adults in our data derived at least the free choice inference.

The *Only Exclusivity* grammar is, in principle derivable, though it was unattested in our data. In this grammar, illustrated in (70), children have access to the full set of alternatives, but apply the exhaustification procedure locally. The relevant set of alternatives is provided in (71),

and the associated derivation is shown in (72). Because the *Exh* operator takes scope below the modal, the strengthening procedure works exactly as it does for regular scalar implicatures in simple disjunction: the conjunctive alternative is negated, yielding an exclusivity inference.[27]

(70) It is possible that Liz buys either a croissant or a donut, but not both.
$\Diamond[(P \vee Q) \wedge \neg(P \wedge Q)]$

(71) **Sets of alternatives for the first round of exhaustification to derive (70):**
a. Complete set of alternatives:
$ALT(P \vee Q) = \{(P \vee Q), P, Q, (P \wedge Q)\}$
b. Set of Innocently Excludable alternatives:
$ALT^{\text{IE}}(P \vee Q) = \{P, (P \wedge Q)\} \cap \{Q, (P \wedge Q)\}$
$= \{(P \wedge Q)\}$

(72) ***Only Exclusivity* derivation:**
$\Diamond[Exh(ALT(P \vee Q))(P \vee Q)] \Leftrightarrow \Diamond[\underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg ALT^{\text{IE}}(P \vee Q)}_{\text{Negating IE Alternatives}}]$
$\Leftrightarrow \Diamond[\underbrace{(P \vee Q)}_{\text{Prejacent}} \wedge \underbrace{\neg(P \wedge Q)}_{\text{Exclusivity}}]$

Note, importantly, that the logic for the *Only Exclusivity* grammar developed above ($\Diamond[(P \vee Q) \wedge \neg(P \wedge Q)]$) does not match the predicted *Only Exclusivity* interpretation in Table 2 ($\Diamond[P \vee Q] \wedge \neg\Diamond[P \wedge Q]$). The paraphrase in (70) indicates that there is a possible world in which Liz buys either a croissant or a donut, but not both. In contrast, the originally predicted interpretation is stronger, as it entails that it is impossible for Liz to buy both pastries. This *Strong Only Exclusivity* interpretation, however, cannot be derived without an additional assumption that is developed below.

Each of the aforementioned grammars assumes that children apply the exhaustification procedure in an adult-like manner. However, it is also plausible that some children engage in a non-adult-like version of this procedure. Since a second round of exhaustification is in principle permitted, children may be capable of initiating the exhaustification procedure but fail to complete the full reasoning, stopping after the first round. If this is the case, the two additional grammars outlined in Table 13 become relevant.

Status	Grammar	Set of alternatives	*Exh*	Interpretation
Non-target	Vacuous Enrichment	Incomplete	Global / Local 1 round of *Exh*	$\Diamond(P \vee Q)$
Unattested	Strong Only Exclusivity	Complete	Global 1 round of *Exh*	$\Diamond(P \vee Q) \wedge \neg\Diamond(P \wedge Q)$

Table 13: Key properties of two grammars assuming an incomplete exhaustification procedure.

[27] Although the statement still bears some ignorance about which of the two disjuncts is true, thus triggering the *Exh* parsing strategy again at the global level, a second round of exhaustification remains illicit because it would yield a contradiction between the newly derived conjunctive inference and the formerly derived exclusivity.

The *Vacuous Enrichment* grammar assumes that children lack the conjunctive alternative and apply an incomplete exhaustification procedure, halting after the first round, whether it occurs globally (see derivation in 60) or locally (see derivation in 65). As a result, the *Vacuous Enrichment* grammar yields the same interpretation as the *Modal Inclusive* grammar, and is thus indistinguishable from it. Note, this grammar raises the possibility that the set of children lacking the conjunctive alternative (which already includes *Free Choice without Exclusivity* and *Modal Conjunctive* children) could be even larger than previously thought, potentially covering the entire sample.

The *Strong Only Exclusivity* grammar assumes that children reason with a complete set of alternatives and apply an incomplete exhaustification procedure at the global level. Consequently, only the modal exclusivity inference $\neg\Diamond(P \wedge Q)$ is derived.

Notice that, at present, we lack a reliable empirical method for determining whether children engage in one or two rounds of exhaustification. Furthermore, these two grammars are predicted to arise only within an exhaustification framework in which the free choice inference and the exclusivity inference are derived in separate rounds. In contrast, this is not the case in Bar-Lev and Fox's (2020) account of the exhaustification procedure, where both inferences are derived within a single round. Consequently, under Bar-Lev and Fox's (2020) account, additional assumptions would be required to derive the *Vacuous Enrichment* and *Strong Only Exclusivity* grammars, an issue we leave open for future investigation.

7.4 Why would children resort to local exhaustification?

In sections 7.2 and 7.3, we proposed a formal implementation of the four attested patterns, centred around two parameters: (i) the nature of the set of alternatives under consideration; and (ii) the locus of the exhaustification procedure. We showed that a *Modal Conjunctive* interpretation can be generated if children lack the scalar conjunctive alternative and, moreover, if the exhaustification procedure occurs locally (i.e., below the modal). A remaining question, however, is what might motivate this early insertion of the exhaustification operator. More specifically, what component of the child's grammar triggers a pragmatic enrichment procedure at a local level rather than at a global one?

This section explores two possible explanations for why some children might prefer local exhaustification in the context of modal disjunction. Section 7.4.1 discusses an apparent tendency for children to provide complete answers to the Question under Discussion and how it relates to ignorance. Section 7.4.2 proposes a novel account attributing the availability of local exhaustification to a bias toward resolving ignorance inferences as early as possible.

7.4.1 A preference to provide complete answers to the Question under Discussion

To explain why children prefer to recursively exhaustify rather than deriving no implicature at all, Singh et al. (2016), following Gualmini et al. (2008), argue that children who derived the conjunctive interpretation in their study favoured a parse that yields a complete answer to the Question under Discussion and disregard any parse that results in a partial answer. The Question under Discussion (Groenendijk & Stokhof, 1984; Roberts, 1996; Stalnaker, 1978) refers to the main contextual element under consideration in the discourse. It takes the form of an (implicit) question to which each sentence of the current conversation either answers or updates with new content. In the case of a simple disjunctive statement, such as (73a), only a grammar yielding the conjunctive interpretation leads to a complete answer to the Question under Discussion in (73b) because it resolves ignorance about each alternative. In contrast, a grammar yielding the adult-like exclusivity inference only resolves ignorance about the

conjunctive alternative, leaving unresolved the ignorance about which disjunct is true, and thus providing only a partial answer to the Question under Discussion.

(73) a. Liz bought a croissant or a donut.
b. What Liz did buy?

However, this explanation does not fit well the case of modal disjunctive statements. To illustrate, take the sentence in (74a) and the related Question under Discussion in (74b).

(74) a. Liz can buy a croissant or a donut.
b. What Liz can buy?

As summarised in Table 14, regardless of whether the exhaustification procedure occurs globally or locally, three of the five grammars provide a complete answer to (74b): the *Free Choice with Exclusivity*, the *Free Choice without Exclusivity*, and the *Modal Conjunctive* grammars. Notice that, for the *Free Choice without Exclusivity* and the *Modal Conjunctive* grammars, the conjunctive alternative is not generated and as such does not count toward assessing a complete answer. As a result, since there are three possible grammars that lead to a complete answer to the Question under Discussion, there is no apparent reason for children to prefer a local exhaustification procedure over a global one, and vice versa.

Grammar	**Set of alternatives**	**Locus of *Exh***	**Ignorance cleared about**		**Answer to the QuD**
			$[\Diamond]P/[\Diamond]Q$	$[\Diamond](P \wedge Q)$	
Free Choice with Excl.	$\{\Diamond P, \Diamond Q, \Diamond(P \wedge Q)\}$	Global	✓	✓	Complete
Free Choice without Excl.	$\{\Diamond P, \Diamond Q\}$	Global	✓		Complete
Only Exclusivity	$\{P, Q, (P \wedge Q)\}$	Local	×	✓	Partial
Modal Conjunctive	$\{P, Q\}$	Local	✓		Complete
Modal Inclusive	Not relevant	Not relevant			None

Table 14: Completeness of the answer to the Question under Discussion for each pattern of interpretation; grey cells indicate that the corresponding alternative is not relevant for the Question under Discussion. Excl. = Exclusivity

Note that the *Only Exclusivity* grammar is the only one in which the exhaustification procedure produces a partial answer to the Question under Discussion, as ignorance about which of the two disjuncts is true remains unresolved. If Singh and colleagues are correct nonetheless, and children capable of pragmatic enrichment tend to prefer interpretations leading to complete answers, then it is unsurprising that we did not find any *Only Exclusivity* children. This observation aligns with a robust finding in the literature: children tend to disprefer under-informative statements (Barner et al., 2011; Heredia Murillo, 2023; Katsos & Bishop, 2011; Huang & Snedeker, 2009; Noveck, 2001; among many others), of which sentences carrying ignorance inferences are a subtype. In the next section, we develop a revised parsing strategy for the *Exh* operator that is specifically guided by this observed tendency to dislike such

statements. In particular, we show that the conjunctive interpretation of disjunction embedded under *every* reported by Singh et al. (2016) and the *Modal Conjunctive* interpretation, both accounted in terms of local exhaustification with a set of alternatives lacking the conjunctive one, is not a coincidence, but rather the consequence of a preference to resolve ignorance inferences as early as possible.

7.4.2 Resolving ignorance inferences as early as possible: The *Exh*-low parsing strategy

After demonstrating that local exhaustification cannot be motivated on the sole basis of providing a complete answer to the Question under Discussion, we will now propose a novel account, which builds on the hypothesis that children prefer to resolve ignorance as early as possible. A straightforward way to integrate ignorance as a determining factor for the locus of exhaustification is to consider the licensing conditions of the *Exh* operator. Our proposal is to adapt the *Exh* parsing strategy proposed by Fox (2007) (12) to reflect a strategy that enforces the insertion of the *Exh* operator at the structurally lowest level of a sentence, which we will call the *Exh*-low parsing strategy (75). Importantly, as with the original *Exh* parsing strategy, the main trigger for the local exhaustification procedure is the presence of ignorance inferences (i.e. condition 75b).

(75) ***Exh*-low parsing strategy:**
   a. Take a sentence S.
   b. Take the structurally lowest sub-constituent α of S that generates undesired ignorance inferences.
   c. Append *Exh* to α.

Compare in Figure 11 and Figure 12 two distinct derivations, corresponding to two different parsing strategies for the *Exh* operator. In Figure 11, the standard *Exh* parsing strategy from Fox (2007) is applied: the exhaustification procedure occurs globally, above the modal, producing a free choice interpretation. Speakers using the standard *Exh* parsing strategy can tolerate ignorance and therefore wait for the sentence to be structurally complete before initiating the exhaustification procedure, ignoring the ignorance arising in the disjunctive sub-constituent. In contrast, in Figure 12, the *Exh*-low parsing strategy is active. Children cannot tolerate ignorance and do not wait for the entire structure to be complete before initiating exhaustification. As a result, the ignorance generated from the disjunctive sub-constituent triggers a local exhaustification procedure, yielding a *Modal Conjunctive* interpretation.

Although the *Exh*-low parsing strategy can explain why children would exhaustify locally, it also faces some challenges. First, the *Exh*-low parsing strategy is not experimentally grounded. While several studies showed that children typically dislike under-informative sentences (Barner et al., 2011; Heredia Murillo, 2023; Katsos & Bishop, 2011; Huang & Snedeker, 2009; Noveck, 2001; among many others), such as sentences typically carrying ignorance inferences like disjunctive statements, no acquisition study has specifically investigated if children were capable of reasoning on ignorance arising from sub-constituents to begin with.[28]

Second, proposing the *Exh*-low parsing strategy raises a question about its generalisability across contexts. If children employ the *Exh*-low parsing strategy to derive the *Modal Conjunctive* interpretation, it is expected that these conjunctive interpreters also employ this parsing strategy in other environments where the *Exh* operator applies. One such context would be disjunctive statements embedded under universal quantifiers such as every (76a). As mentioned before, Singh et al. (2016) found that, in this context too, children provided

[28] But see footnote 26 to understand why this is necessary for adults.

conjunctive answers (76b). To account for this interpretation, Singh and colleagues had to assume that the exhaustification occurred locally, below the universal quantifier, which makes it parallel to the conjunctive strengthening of simple disjunctive statements (77), and ultimately supports the *Exh*-low parsing strategy account.

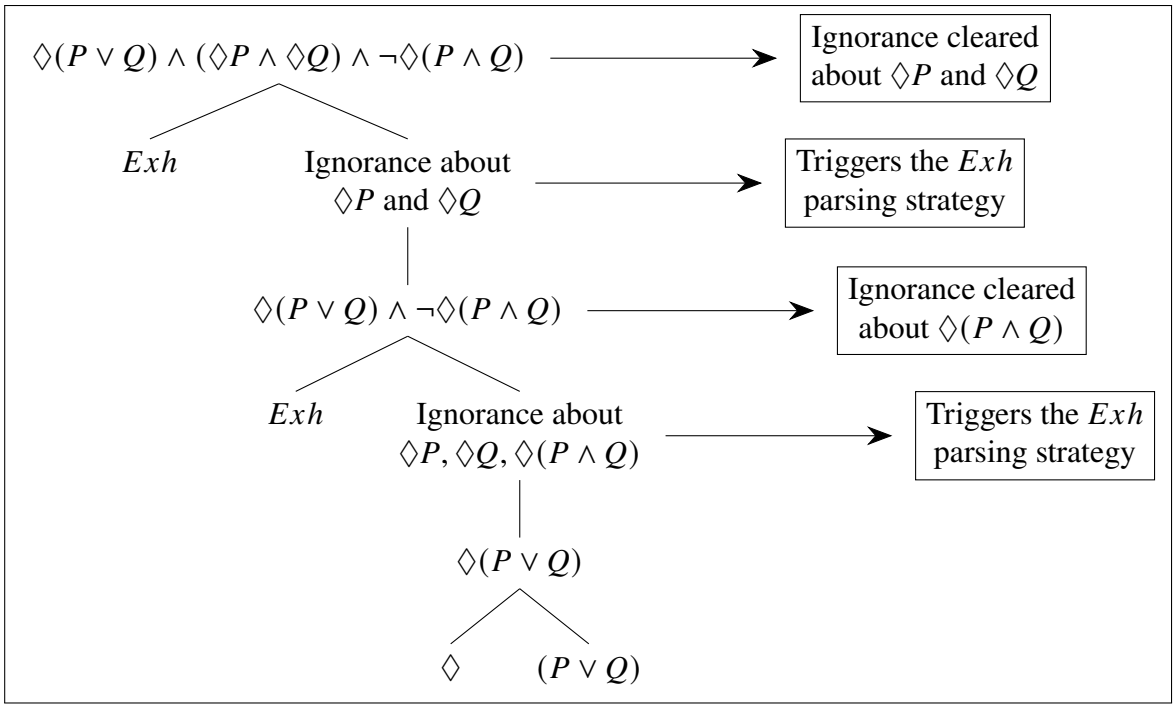


Figure 11: Applying the regular *Exh* parsing strategy.

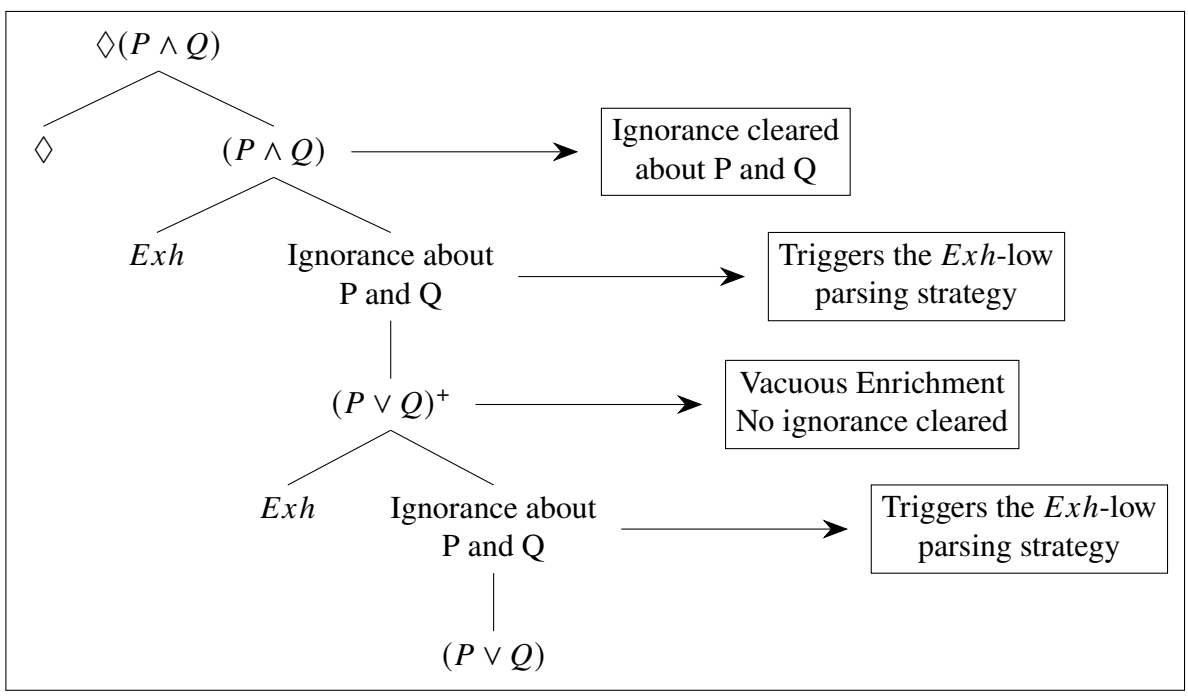


Figure 12: Applying the *Exh*-low parsing strategy.

(76) a. Every boy is holding an apple or a banana. $\forall x(Px \vee Qx)$
b. $\rightsquigarrow$ Every boy is holding an apple and a banana. $\forall x(Px \wedge Qx)$

(77) Every x(*Exh*(*Exh*(x is holding an apple or a banana.)))

We close this section by showing that the *Exh*-low parsing strategy is mostly harmless in another context: negated disjunction[29] (78).

(78) Liz did not buy a croissant or a donut. $\neg(P \vee Q)$

Assuming that negation takes scope over disjunction, the *Exh*-low parsing strategy targets the disjunctive sub-constituent, aiming to resolve ignorance as early as possible. With a complete set of alternatives, as in (79a), the first round of local exhaustification yields a bi-conditional interpretation (79b): Liz either bought both pastries or bought none of them. However, to our knowledge, this interpretation has not been attested in previous acquisition studies on negated disjunction (Goro, 2007; Goro & Akiba, 2004; Pagliarini et al., 2022; Geçkin et al., 2018; Cochard et al., 2023; among many others, see also Chapter 3). A plausible explanation is that, similar to the *Only Exclusivity* interpretation in modal disjunction, this bi-conditional interpretation is dispreferred by children because it maintains ignorance over two distinct situations (buying both vs. buying none).

(79) a. $ALT(P \vee Q) = \{(P \vee Q), P, Q, (P \wedge Q)\}$
b. $\neg(Exh(P \vee Q)) \Leftrightarrow \neg[(P \vee Q) \wedge \neg(P \wedge Q)]$
$\Leftrightarrow (P \leftrightarrow Q)$

With an incomplete set of alternatives, as in (80a), a single round of exhaustification is vacuous, leading to the reading in (80b): Liz bought neither the croissant nor the donut. This interpretation fully resolves ignorance and moreover corresponds to the interpretation that children usually show in previous studies (Goro, 2007; Goro & Akiba, 2004; Pagliarini et al., 2022; Geçkin et al., 2018; Cochard et al., 2023; among many others, see also Chapter 3). Note that a local exhaustification procedure with two rounds yields a weaker interpretation than the starting meaning (80c). This weakening behaviour is functionally prohibited and, thus, rules out a second round.

(80) a. $ALT_{\text{CHILD}}(P \vee Q) = \{(P \vee Q), P, Q\}$
b. $\neg(Exh(P \vee Q)) \Leftrightarrow \neg(P \vee Q)$
$\Leftrightarrow (\neg P \wedge \neg Q)$
c. $\neg(Exh(Exh(P \vee Q))) \Leftrightarrow (\neg P \vee \neg Q)$

[29] Contrary to the general assumption that *Exh* cannot be inserted below a downward-entailing operator, Chierchia et al. (2011) pointed out that inserting *Exh* below negation is required to account for some meta-linguistic strategies that use pitch accent, such as in (ia). Here the negated disjunctive statement carries a pitch accent on the disjunctive word, allowing for a conjunctive interpretation to arise with the right continuation. According to Chierchia et al. (2011), the derivation in (ib), in which an *Exh* has been inserted between the negation and the disjunctive statement, yields the desired conjunctive interpretation.

(i) a. John did not talk to Mary OR Sue. He talked to both.
b. $Exh(\neg(Exh(P \vee Q))) \Leftrightarrow (P \vee Q) \wedge \neg[(P \vee Q) \wedge \neg(P \wedge Q)]$
$\Leftrightarrow (P \wedge Q)$

7.5 Predictions across age and contexts

In this section, we propose two sets of predictions regarding, on the one hand, the developmental trajectory in Section 7.5.1 and, on the other hand, the expected interpretations if non-adult-like mastery of disjunction carries over to other contexts in Section 7.5.2.

7.5.1 A clear developmental trajectory

By manipulating two components, whether the conjunctive alternative has been included in the set of relevant alternatives and whether exhaustification occurred globally or locally, we identified a grammar for each of the four attested patterns in our data. These grammars appear to form a clear developmental trajectory summarised in Table 15.

Stage	Exhaustification	Conjunctive alternative	Expected pattern
1	No insertion of *Exh*		Modal Inclusive
2	Local *Exh*	×	Modal Conjunction
3	Global *Exh*	×	Free Choice without Exclusivity
4	Global *Exh*	✓	Free Choice with Exclusivity

Table 15: Hypothesised developmental trajectory.

In the first stage, children show no visible inference. This may stem from two possibilities: (i) children have yet to learn that disjunctive statements can be pragmatically enriched; (ii) children know how to deploy the *Exh* operator but do so in a non-adult-like way, lacking the conjunctive alternative and not proceeding beyond the first round of exhaustification. Importantly, this stage cannot be mistaken for an adult-like stage where children would have the possibility to cancel both inferences, as this never occurred in our data for adults. Crucially, this stage should not be mistaken for a hypothetical adult-like stage in which both inferences are cancelled, since such a pattern never occurred in our adult data.

In the second stage, children have the ability to produce pragmatically enriched meanings, but do not do so in the same way as adults: the set of alternatives under consideration does not contain the scalar alternative and, moreover, the exhaustification procedure occurs locally. At this stage, the *Exh*-low parsing strategy is active, enjoining children to resolve ignorance inferences as early as possible, resulting in a *Modal Conjunctive* interpretation.

For the third stage, there are in principle two possibilities: either children switch to the regular *Exh* parsing strategy and insert the *Exh* operator globally, or they learn that disjunction and conjunction form a scale and can include the latter in the set of relevant alternatives. If children acquire the adult-like set of alternatives first, but still proceed to a local pragmatic enrichment, an *Only Exclusivity* interpretation is expected (see derivation in Section 7.3). However, as this reading was unattested in our studies, we conclude that this cannot be the right trajectory. Conversely, if children learn first to produce pragmatically enriched meanings at a global level, but still lack the conjunctive alternative, a *Free Choice without Exclusivity* is expected.

The last and final stage corresponds to the adult grammar. Here, the conjunctive alternative is finally introduced in the set of relevant alternatives, which allows for both the free choice and the exclusivity inferences to be generated. Notice that, if children are really adult-like, they should be able to cancel the additional exclusivity inference like adults. If so, this would cast doubt on whether children at the third stage are truly non-adult-like or adult-like children

at stage four in disguise. However, we take the nearly systematic absence of this inference as a signal that children at stage three are mostly non-adult-like.

7.5.2 From modal disjunction to simple disjunction

Another question is whether the interpretive patterns observed for modal disjunction extend to other contexts with disjunction. Assuming that children's mastery of disjunction carries over across contexts, Figure 13 summarises the expected interpretations for both simple and modal disjunction. The predictions vary depending on the two factors we defined in Section 7.2 and manipulated in Section 7.3: (i) whether *Exh* has been inserted, and if so, locally or globally; and (ii) whether the conjunctive alternative is included in the set of relevant alternatives. Children who do not exhaustify (assuming they are constrained from doing so rather than choosing not to; cf. Singh et al. 2016; p. 42) are not expected to derive any inference in either simple or modal disjunction. Children who lack the conjunctive alternative are predicted to show a conjunctive interpretation in simple disjunctive statements (Singh et al., 2016), but a *Modal Conjunctive* interpretation or *Free Choice without Exclusivity*, depending on the locus of exhaustification. Finally, children who possess the adult-like set of alternatives are predicted to show an exclusive interpretation in simple disjunction, and either an *Only Exclusivity* or a *Free Choice with Exclusivity* interpretation in modal disjunction, depending on whether enrichment occurs locally or globally.

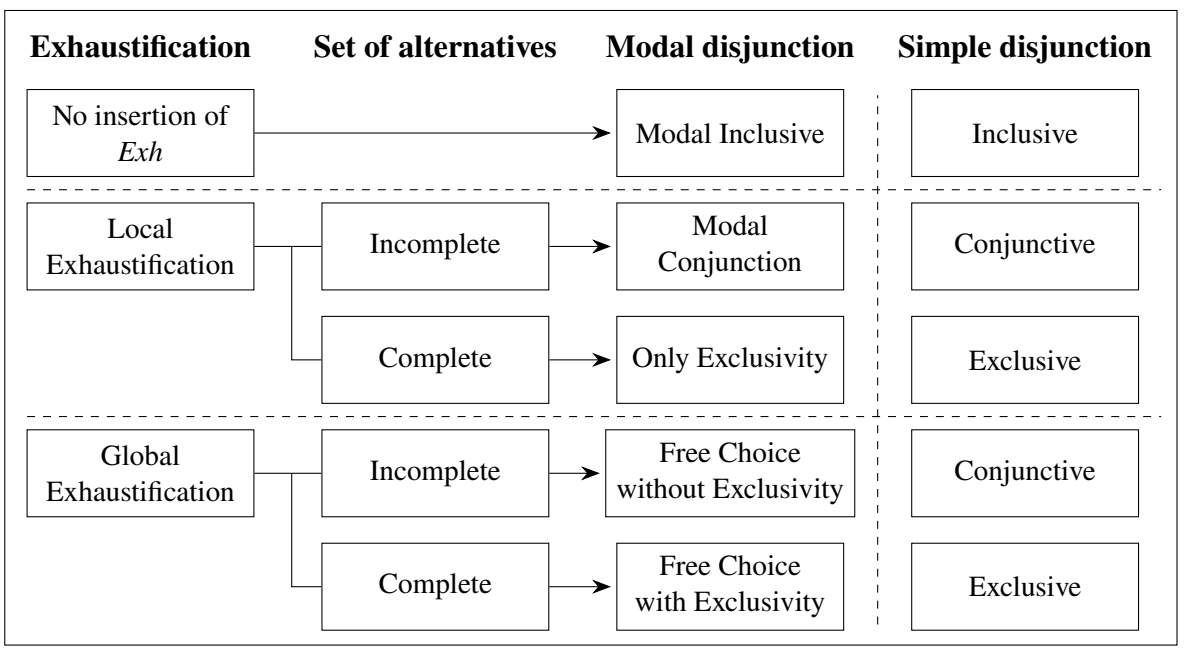


Figure 13: Predictions for modal disjunction and simple disjunction according to the two parameters introduced in Section 7.2.

8 Concluding summary

Prior acquisition studies have reported non-adult-like conjunctive readings of disjunction in simple contexts, suggesting that children have not yet acquired the adult-like meaning of disjunction (Braine & Rumain, 1981; Paris, 1973; Singh et al., 2016; Tieu et al., 2017; Cochard et al., 2023; Bleotu et al., 2023; Lobina et al., 2023a). To account for these non-adult-like conjunctive readings of simple disjunction, Singh et al. (2016) proposed that children have the ability to produce pragmatically enriched meanings but not in the same way as adults,

rendering it similar to the adult conjunctive strengthening process that yields the free choice inference in modal disjunction. A key prediction of Singh and colleagues is that children should be able to compute the free choice inference. This seemed to have been confirmed as previous studies have indeed reported that the free choice inference is acquired by age 5 (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020). However, we argued in section 3 that this conclusion is undermined by an alternative explanation for children's seemingly adult-like responses in modal disjunction, namely, that children draw a *Modal Conjunctive* inference rather than a genuine free choice inference. Previous experimental designs could not distinguish between free choice and modal conjunction, as these two interpretations share similar verification and falsification conditions. To test whether children truly derive an adult-like free choice interpretation, or, instead, generate a *Modal Conjunctive* interpretation, we designed an acquisition experiment that includes two novel types of conditions: a *Mutually Exclusive* scenario, in which both disjuncts are permitted but not simultaneously, and a *Package* scenario, in which both disjuncts are conjointly permitted but not separately. Furthermore, our design can also reveal another inference that is optionally associated with free choice: the exclusivity inference. Exclusivity in modal disjunctive statements has received little attention in adult experiments and has been completely absent from acquisition studies.

The results from French adults showed, unsurprisingly, that the free choice inference was always derived. In addition, the optional exclusivity inference was generally preferred, though not universally calculated, as approximately two out of three adults did so.

Half of the children demonstrated a genuine adult-like free choice interpretation, while the other half exhibited either a non-adult-like *Modal Inclusive* interpretation or, crucially, a *Modal Conjunctive* interpretation. Without the inclusion of a *Mutually Exclusive* scenario in our experimental design, these children would have been misclassified as adult-like free choice interpreters. Furthermore, we have identified *Modal Inclusive* children who did not show any visible inference, which also constitutes a novel observation about acquisition of modal disjunction. Finally, most children did not derive the additional exclusivity inference. Future research is required to determine whether these children treat this inference as optional, like adults, or if they are unable to generate it, because they lack the conjunctive alternative that is necessary to derive this inference.

Finally, alongside the methodological contribution of this study, we proposed an account for the *Modal Conjunctive* interpretation by extending Singh et al.'s (2016) analysis of conjunctive interpretations of simple disjunction and disjunction embedded under *every* to modal contexts. Specifically, we argued that modal conjunction arises as an inference, resulting from (i) an incomplete set of alternatives, lacking the conjunctive alternative, and (ii) a local exhaustification procedure. To explain why a subset of children would produce local pragmatic enrichments, we proposed that *Modal Conjunctive* children follow the *Exh*-low parsing strategy, which enjoins children to resolve ignorance as early as possible in the course of meaning composition.

Chapter 6

Main findings and Open issues

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This dissertation investigated the development of logical language in child French, focusing on how children interpret disjunction across various linguistic environments. In particular, we examined simple, negated, and modal contexts, drawing on different age groups and experimental paradigms. We raised several core questions, particularly regarding which interpretations are available to children and adults, and how these interpretations arise and generalise across contexts.

In Chapter 3, we investigated the acquisition of simple disjunction in conjunction with negated disjunction using the same experimental design and participants. The findings reported in this chapter laid the foundations for two independent investigations. First, in Chapter 4, we looked into the adult variation in negated disjunction, specifically whether prosody was a disambiguating factor. Second, in Chapter 5, we examined whether children's non-adult-like interpretations carry over to modal contexts.

Section 1 presents an overview of the dissertation by summarising the main findings. Section 2 raises the issue of a developmental trajectory for disjunction. Section 3 briefly highlights outstanding issues for future studies. Section 4 explores an alternative explanation for our results and Section 5 concludes.

1 Main findings

Section 1.1 summarises the main highlights of the dissertation. Section 1.2 presents the main findings for adults, while Section 1.3 presents the key results for children.

1.1 Overview of main findings

This dissertation investigates how French speakers, both adults and children, interpret disjunctive statements in three environments: simple disjunction (1a), negated disjunction (1b), and modal disjunction (1c). Across these contexts, the results revealed variation within the adult population and systematic (non-)adult-like interpretations for children.

(1) a. **Simple disjunction:** Liz bought a croissant or a donut.
b. **Negated disjunction:** Liz did not buy a croissant or a donut.
c. **Modal disjunction:** Liz can buy a croissant or a donut.

Adults

- **There are two adult populations in negated disjunction:** In negated disjunction, adults feature two populations with distinct interpretive preferences. One group of speakers preferred to interpret disjunction above negation, deriving either a *not both* or an *exclusive* interpretation. This group represented approximately two-thirds of all adults. The other group interpreted disjunction below the scope of negation, showing a *neither...nor* interpretation. To account for this variation, we proposed in Chapter 4 reconsidering Szabolcsi's (2002) cross-linguistic positive polarity parameter by arguing that it also operates at the individual level, some speakers being +PPI and others –PPI. Concurrently, we suggested that scope can be accounted syntactically, with prosody providing cues to the underlying syntactic structure of a negated disjunctive statement, either phrasal coordination or clausal coordination.
- **Prosody is a disambiguating factor:** Chapter 4 has demonstrated that adults are generally sensitive to prosody in negated disjunctive statements. For a majority of adults, prosody modulated the interpretation: a prosodic contour with a pitch accent on disjunction favoured the *exclusive* interpretation, whereas a prosodic contour carrying a pitch accent on negation

favoured the *neither...nor* interpretation. Yet, there was also a group of speakers who appeared to be oblivious to our prosodic manipulations, showing a preference for one or the other reading.

- **The exclusivity inference is optional:** Adults do not uniformly derive the exclusivity inference. In simple disjunction, some adults derived an inclusive interpretation but this pattern was marginal. In negated disjunction a significant number of participants exhibited the *not both* interpretation. In modal disjunction, roughly one-third of all adults derived the *Free Choice without Exclusivity* interpretation. We speculated that these speakers first generated this inference and subsequently cancelled it, a behaviour that is also marginally attested in simple and negated disjunction in Chapter 3. This was necessary to explain the difference with children who did not derive this inference either.

Children

- **Children have consistent grammar across simple and negated contexts:** In Chapter 3, we found that children displayed systematic patterns in simple disjunctive statements (*exclusive*, *inclusive* and *conjunctive* readings), in negated disjunctive statements (*exclusive* and *neither...nor* readings), and critically across the two contexts. Most importantly, there were no attested patterns that would reflect an inconsistent grammar (e.g. *conjunctive* in simple disjunction but *exclusive* in negated disjunction) and all patterns predicted to arise if children have a consistent grammar across contexts were attested (see Section 1.3.1 for details). We argued that each pattern corresponds to a grammar that can be explained by the interaction of three components: the availability of a pragmatic (grammatical) enrichment mechanism (e.g. the exhaustification operator), the nature of the set of alternatives (complete or incomplete) and the scope of disjunction relative to negation. In particular, we followed Singh et al.'s (2016) proposal that *conjunctive* children possess the adult-like ability to insert the *Exh* operator in the syntactic structure to derive enriched meanings, but lack the conjunctive alternative from the relevant set of alternatives under consideration.
- **Adult vs non-adult *neither...nor* readings:** Given the adult variation in interpreting negated disjunctive statements, children's *neither...nor* responses could have reflected an adult-like grammar. By using performance on simple disjunction as an indicator of adult-likeness with disjunction overall, we were able to tease apart non-adult-like *neither...nor* readings from adult-like ones. We proposed further that *neither...nor* responses can arise from three distinct sources: (i) a genuine adult-like preference to interpret disjunction below the scope of negation, (ii) a non-adult-like preference for the scope configuration generating the reading carrying the least ignorance, or (iii) a non-adult-like parse in which disjunction is interpreted above negation and is subsequently pragmatically enriched to a *neither...nor* reading.
- **Children do not reach an adult-like performance in modal disjunction:** In Chapter 5, we found that slightly more than half of the children derived the free choice inference, contrary to adults, who all derived it. Moreover, among the children who derived a free choice interpretation, only a minority derived the additional exclusivity inference. To explain the absence of this inference, it is plausible that, like adults, these children derived the inference and then cancelled it. However, this explanation was insufficient to account for the near-complete absence of this inference with children. To resolve this issue, we proposed that a *Free Choice without Exclusivity* reading can arise if children know how to pragmatically enrich modal disjunction (by means of the *Exh* operator) but do it with

respect to an incomplete set of alternatives, lacking the modal conjunctive alternative. The remaining children, who did not show a free choice inference, were divided between *Modal Inclusive* interpreters, showing no visible pragmatic enrichment, and *Modal Conjunctive* interpreters who performed a non-adult-like pragmatic enrichment procedure.

- □ **Modal conjunction arises via a local non-adult-like pragmatic enrichment:** The *Modal Conjunctive* interpretation represents a theoretical challenge that we accounted for in Chapter 5. Specifically, we argued that a *Modal Conjunctive* interpretation arises when three conditions are met: (i) children can insert the *Exh* operator and produce enriched meanings; (ii) the conjunctive alternative is missing from the set of alternatives under consideration; and, critically, (iii) the enrichment procedure occurs at the local level, between the modal and the disjunctive sub-statement. We speculated further on the reasons why children would resort to a local parse and proposed that children are sensitive to the ignorance inferences typically associated with disjunction. The gist of our proposal was that *Modal Conjunctive* children seek to resolve ignorance as early as possible, thus triggering a local enrichment procedure.
- □ **Some children prefer to resolve ignorance inferences as early as possible:** A central conclusion of our analysis is that children display a bias toward eliminating ignorance inferences at the earliest point in meaning composition. In modal disjunction, we modelled this preference with the *Exh*-low parsing strategy, a revised licensing condition for the *Exh* operator that triggers the exhaustification procedure locally, between the modal and the disjunctive sub-statement ($\Diamond > Exh > \vee$). This parse yields the *Modal Conjunctive* interpretation and, crucially, resolves all ignorance earlier than any other parse. Critically, the preference to resolve ignorance carries beyond modal contexts. In simple disjunction, it predicts the *conjunctive* reading, and in negated disjunction the *neither...nor* reading: both interpretations eliminate ignorance entirely. In this way, our account unifies children's non-adult-like interpretations of disjunction under a general tendency for resolving ignorance as much and as early as possible.

1.2 Cross-linguistic variation and speakers preferences

In acquisition studies on disjunction, adult data are often treated as secondary. These data are typically included as a control and are rarely discussed in depth, if they are reported at all. However, a closer examination reveals that they warrant careful investigation. Far from being straightforward, adult responses frequently display subtle patterns and raise critical questions that should be addressed. As a result, one goal of this dissertation was to explore adult interpretation in simple, negated and modal contexts, and show that careful experimentation and thorough analysis of the corresponding data is crucial for a better understanding of typological variation as well as for interpreting children's patterns in the acquisition of disjunction. The findings for the adult interpretation of negated disjunction and modal disjunction are reported in Sections 1.2.1 and 1.2.2, respectively.

1.2.1 The relative scope of disjunction: Two adult populations

The starting point of our investigation into the interpretation of negated disjunctive statements was a disagreement between claims in the literature and the author's native speaker judgements. The negated disjunctive statement in (2) is logically ambiguous between the *neither...nor* reading (i.e., no disjunct is true; 2a), arising from negation taking scope over disjunction, and the *not both* reading (i.e., at most one disjunct is true; 2b), arising from disjunction taking scope over negation. The *not both* reading can moreover be strengthened to the *exclusive*

reading (i.e., exactly one disjunct is true; 2c) via scalar implicature.

(2) Liz n'aime pas les mathématiques ou la géographie.
Liz AUX.3SG.PRS NEG DET mathematics or DET geography
Lit. "Liz does not like mathematics or geography."
a. **NEG > OR:**
Liz likes neither mathematics nor geography.
b. **OR > NEG:**
Liz does not like mathematics or she does not like geography, possible neither.
c. **OR > NEG + Scalar implicature:**
Either Liz does not like mathematics or she does not like geography.

Numerous studies found that the preferred interpretation for (2) varies cross-linguistically. Szabolcsi (2002) proposes a parametric account of this variation on which disjunction is a positive polarity item (PPI) which must necessarily take scope over negation. This claim has been supported experimentally in languages such as French (Nicolae, 2017; Pagliarini et al., 2022; Spector, 2014), Italian (Pagliarini et al., 2022, 2018b) and Japanese (Goro, 2007; Goro & Akiba, 2004) among others. However, the status of the French disjunction word *ou* "or" as a PPI is controversial. The adult participants in Larralde et al. (2021) were reported to unambiguously prefer the *neither...nor* interpretation. In parallel, Lungu et al. (2021) found a more nuanced picture of French adults' interpretation of negated disjunction, showing that both *exclusive* and *neither...nor* readings could be accessed in an acceptability judgement task. In response to these discrepancies, the studies in Chapter 3 and Chapter 4 sought to provide a more detailed understanding of the available interpretations for French adult speakers.

To this aim, three studies testing the interpretation of negated disjunction were run. In Chapter 3, negated disjunction was presented alongside simple disjunction to see if participants' performance was correlated in both contexts. In Chapter 4, a forced-choice task and a truth-value judgement task were run to evaluate the role of prosody in interpreting negated disjunction. In the forced-choice task, participants were prompted to read a disambiguating story and then to choose between two prosodic variants of the same disjunctive statement. In the truth-value judgement task, two separate groups of participants were prompted to judge whether a disjunctive guess was right or wrong. One group heard a prosodic contour favouring the *exclusive* interpretation (labelled "OR Prosody"), while the other group heard a different one favouring the *neither...nor* reading (labelled "NEG Prosody"). Table 1 summarises the individual result patterns for the truth-value judgement tasks from Chapter 3 and Chapter 4, and Table 2 summarises the results from the forced-choice task.

	Pattern of interpretation			**Inconsistent pattern**
	Exclusive	**Not both**	**Neither...nor**	
Chapter 3 (n = 73)	34 (46.6%)	10 (13.7%)	14 (19.2%)	15 (20.5%)
Chapter 4: OR Prosody (n = 38)	17 (44.7%)	7 (18.4%)	9 (23.7%)	5 (13.2%)
Chapter 4: NEG Prosody (n = 38)	6 (15.8%)	6 (15.8%)	15 (39.5%)	11 (28.9%)

Table 1: Patterns of interpretation for the truth-value judgement tasks from Chapters 3 and 4.

	Probability of choosing the...	
Story Type	**OR Prosody**	**NEG Prosody**
Exclusive	75.9% [63.4% - 85.1%]	24.1% [14.9% - 36.6%]
Neither...nor	14.8% [9.2% - 23.0%]	85.2% [77.0% - 90.8%]

Table 2: Probability of choosing either of the two prosodic contours depending on the story type. 95% confidence intervals in brackets.

Two main findings emerged from the results. First, the truth-value judgement tasks from Chapter 3 and Chapter 4 revealed that French adults accessed all three possible interpretations of negated disjunctive statements, including the allegedly unavailable *neither...nor* reading. Second, the studies in Chapter 4 demonstrated that both the *exclusive* and the *neither...nor* interpretations can be independently primed by prosody. When the story supported the *neither...nor* reading, participants were more likely to select a contour with a pitch accent on negation; conversely, when the story favoured the *exclusive* reading, they preferred a contour with a pitch accent on disjunction. However, the truth-value judgement tasks also revealed that, while prosody guided interpretation for some participants, others exhibited a rigid interpretive preference that persisted regardless of prosodic cues.

Taken together, the results suggest the existence of two adult populations with distinct interpretive preferences in French. One population prefers to interpret disjunction as taking scope over negation, resulting in either a *not both* or an *exclusive* interpretation, depending on whether the exclusivity inference is derived. The other population prefers to interpret disjunction under the scope of negation, yielding a *neither...nor* interpretation as per De Morgan's laws. Moreover, independently of these scope preferences, French speakers appear to divide into two groups based on sensitivity to prosody: for some, prosody modulates access to the available interpretations, while for others, interpretation appears unaffected by it.

These findings have two key theoretical implications. First, the variation observed among French speakers challenges the assumption that French disjunction *ou* is a positive polarity item (PPI). To account for this variation, we proposed a revision of Szabolcsi's (2002) cross-linguistic PPI parameter for disjunction and discussed two possibilities. One option is that the parameter operates at the individual level (i.e., between speakers). This possibility would explain why roughly two-thirds of the tested French speakers interpreted disjunction above negation (yielding either an *exclusive* or a *not both* reading), while the remaining one-third interpreted it below negation (yielding a *neither...nor* reading). The reason is that the *neither...nor* reading arises only in the –PPI group of interpreters, whereas the two other readings appear in both –PPI and +PPI interpreters, and therefore should be more prevalent. Moreover, this account suggests that French may currently be undergoing a grammatical change, switching from one value of the parameter to the other.

A second option is that scope is encoded syntactically rather than semantically. Under this approach, the level of coordination in the disjunctive statement determines which interpretation is available: when disjunction coordinates two phrases (e.g., two DPs or NPs), only the *neither...nor* reading should be possible; when disjunction coordinates two clauses, only the *not both* and the *exclusive* readings should be available. In this case, prosody may play a determining role in signalling the underlying syntactic structure of the disjunctive sentence.

Second, the coexistence of both *exclusive* and *neither...nor* interpretations among adult speakers, albeit in different proportions, has implications for theories of language acquisition. In particular, it casts doubt on a key assumption in prior accounts of the acquisition of negated

disjunction in +PPI languages: that *neither...nor* responses from children reflect non-adult-like behaviour. If a sub-group of French adults genuinely and systematically assign a *neither...nor* interpretation to negated disjunction, then children who exhibit the same interpretation may, in fact, be demonstrating an adult-like response. This is discussed in more depth in Section 1.3.1.

1.2.2 The exclusivity inference is not always calculated

By testing modal disjunction in adults with the setup presented in Chapter 5, our goal was twofold. First, we aimed to fill a gap in the experimental literature in which the exclusivity inference in (3a) has never been put to test in modal disjunctive statements. Second, we sought to determine whether the exclusivity inference is systematically derived along with the free choice inference, or whether it can be dissociated (i.e., whether some participants derive free choice without exclusivity or, conversely, exclusivity without free choice). Testing this inference in modal disjunctive contexts was non-trivial as we already found adults who did not derive this inference in simple disjunction (4), showing an *inclusive* reading (8 out of 73 adults, 11%; see Chapter 3), and in negated disjunction (5), showing a *not both* reading (12 out of 73 adults, 16%; see Chapter 3).

(3) Liz can buy a croissant or a donut.
   a. **Exclusivity inference:**
      $\rightsquigarrow$Liz cannot buy both the croissant and the donut. $\neg\Diamond(P \wedge Q)$
   b. **Free Choice inference:**
      $\rightsquigarrow$Liz can buy a croissant and Liz can buy a donut. $\Diamond P \wedge \Diamond Q$

(4) Liz bought a croissant or a donut.
   $\rightsquigarrow$Liz bought a croissant or a donut, but not both. $(P \vee Q) \wedge \neg(P \wedge Q)$

(5) Liz did not buy a croissant or a donut.
   $\rightsquigarrow$Either Liz did not buy a croissant or she did not buy a donut. $(\neg P \vee \neg Q) \wedge \neg(\neg P \wedge \neg Q)$

Critically, while adults readily derived the free choice inference in (3b), they were less consistent with the exclusivity inference in (3a). The individual results, summarised in Table 3, showed that, while a majority of adults computed the exclusivity inference, a non-negligible number did not.

Interpretation	Number
Free Choice with Exclusivity	25/36 (69%)
Free Choice without Exclusivity	11/36 (31%)

Table 3: Adult individual patterns in the free choice task (Chapter 5)

By showing that not all adults derived the exclusivity inference in modal disjunctive statements, two questions emerged. First, to what extent do children derive the exclusivity inference in modal disjunction? While prior research on children's interpretation of modal disjunction has focused exclusively on the acquisition of the free choice inference (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020), demonstrating that preschoolers interpret such statements in an adult-like way, much less is known about the acquisition of the exclusivity inference in modal disjunctive statements. Section 1.3.2 addresses this question. Second, why did adults not always calculate the exclusivity inference? Under the grammatical approach employed in this dissertation (Fox, 2007; Chierchia et al., 2011; Chemla, 2009b; Bar-Lev &

Fox, 2020), we speculated that this inference is first generated before the free choice inference, and then cancelled. This speculation was necessary to explain the difference between children, who consistently fail to derive the exclusivity inference, and adults, who appear to sometimes fail to derive it as well, but for different reasons.

1.3 The L1 acquisition of disjunction in simple, negated and modal contexts

This section summarises the main findings from two acquisition studies: the first compared simple disjunction and negated disjunction within the same design and with the same set of participants, while the second investigated the extent to which children derive genuine free choice inferences. Both studies aimed to broaden the empirical coverage of previous work, which either examined disjunction in only one environment at a time or failed to include the disentangling conditions that turned out to be crucial for identifying genuine (non-)adult-like readings. Section 1.3.1 summarises the findings from Chapter 3, and Section 1.3.2 those from Chapter 5. Finally, Section 1.3.3 discusses how children's interpretations of disjunction may reflect a general bias to resolve ignorance as early as possible. Importantly, throughout this discussion, "pragmatic enrichment" is understood within the grammatical approach, which posits the insertion of an exhaustification operator, *Exh*, into the structure to produce enriched meanings.

1.3.1 Genuine adult-like readings or not? Comparing simple and negated disjunction

Our first acquisition study examined the interpretation of simple disjunction and negated disjunction within a single experimental design. The motivation for such a design arose from the recurring observation in the literature that, in both contexts, some children exhibit a form of strong interpretation. In the case of simple disjunctive statements, these children only accept scenarios where both disjuncts are true ((6c)); Braine and Rumain 1981; Cochard et al. 2023; Paris 1973; Singh et al. 2016; Tieu et al. 2017; Bleotu et al. 2023. In negated disjunctive statements, they accept scenarios in which neither disjunct is true ((7c); Goro and Akiba 2004; Goro 2007; Pagliarini et al. 2022; Geçkin et al. 2018; Cochard et al. 2023). The presence of these two patterns in children's responses raised the question whether they can be both explained by the same underlying cause, motivating a comparative examination between simple and negated disjunctive statements.

(6) Liz bought a croissant or a donut.
   a. Liz bought a croissant or a donut, possibly both. Inclusive
   b. Liz bought a croissant or a donut, but not both. Exclusive
   c. Liz bought a croissant and a donut. Conjunctive

(7) Liz did not buy a croissant or a donut.
   a. Liz did not buy a croissant or she did not buy a donut, possibly neither. Not both
   b. Either Liz did not buy a croissant or she did not buy a donut. Exclusive
   c. Liz bought neither a croissant nor a donut. Neither...nor

However, all previous studies have tested these environments in isolation, never together within the same participants. Assuming that children's underlying pragmatic abilities remain constant across contexts, we hypothesised that the interpretation of disjunction generalises across simple and negated disjunction. If learners show a non-adult-like interpretation in one disjunctive statement, it is likely that they show an equally non-adult-like interpretation in

other contexts, and the converse for children who give an adult-like interpretation.

Our hypothesis was that the nature of a child's grammar remains constant across contexts. If a child does not produce pragmatically enriched meanings, this gap should manifest both in simple and negated disjunction. The same holds if the child's grammar does not generate the full set of lexical alternatives, as proposed by Singh et al. (2016). For instance, a child who does not derive exclusivity in simple disjunctive statements is expected to show the same limitation in negated disjunctive statements, while a child with a complete and adult-like system should behave in an adult-like fashion in both environments.

Following this logic, we argued that three factors jointly determine the interpretation of disjunction across simple and negated contexts: (i) whether the *Exh* operator has been inserted and pragmatic enrichment has occurred, (ii) the composition of the set of relevant alternatives (whether complete or incomplete), and (iii) the scope of disjunction relative to negation (OR > NEG or NEG > OR). To make this distinction concrete, consider the following representations of the set of alternatives assumed for adults in (8) and for children in (9).

(8) **Adult sets of alternatives:**
   a. Simple disjunction: $ALT(P \vee Q) = \{(P \vee Q), P, Q, (P \wedge Q)\}$
   b. Negated disjunction: $ALT(\neg P \vee \neg Q) = \{(\neg P \vee \neg Q), \neg P, \neg Q, (\neg P \wedge \neg Q)\}$

(9) **Child sets of alternatives:**
   a. Simple disjunction: $ALT(P \vee Q) = \{(P \vee Q), P, Q\}$
   b. Negated disjunction: $ALT(\neg P \vee \neg Q) = \{(\neg P \vee \neg Q), \neg P, \neg Q\}$

The predictions generated by the different possible combinations of these components are summarised in Table 4.[1]

Status	**Insertion of *Exh***	**Set of alternatives**	**Simple disjunction**	**Negated disjunction**	
				OR > NEG	**NEG > OR**
Target	✓	Complete set $\{P, Q, (P \wedge Q)\}$	Exclusive $(P \vee Q) \wedge \neg(P \wedge Q)$	Exclusive $(\neg P \vee \neg Q) \wedge \neg(\neg P \wedge \neg Q)$	Neither...nor $(\neg P \wedge \neg Q)$
Non-target	✓	Incomplete set $\{P, Q\}$	Conjunctive $(P \wedge Q)$	Neither...nor $(\neg P \wedge \neg Q)$	
Non-target	×	Not relevant	Inclusive $(P \vee Q)$	Not both $(\neg P \vee \neg Q)$	

Table 4: Predicted patterns for simple and negated disjunction, depending on whether the *Exh* operator has been inserted and on the nature of the set of alternatives.

In designing this study, we sought to address several limitations of previous work. First, earlier studies often included too few items per condition to establish whether participants' interpretations were consistent within a given context. We remedied this by increasing the number of trials per condition and by applying a cluster analysis to identify stable patterns.

Second, the source of the *conjunctive* reading in children has been recently debated. While Singh et al. (2016) and Tieu et al. (2017) argue that such readings reflect a genuine non-adult-

[1] The non-target grammar where the *Exh* operator has not been inserted in the structure (third row of Table 4) must not be confused with a target grammar, not represented here, where the *Exh* operator has been inserted and the resulting inference cancelled (see Section 1.2.2).

like stage, Skordos et al. (2020) have suggested that they may arise from methodological artefacts. We took care to minimise methodological biases by introducing a falsifying scenario for disjunction and by ensuring that ignorance inferences were satisfied, thereby removing one possible source of the *conjunctive* reading.

Finally, we reconsidered the status of the *neither...nor* interpretation. In languages where disjunction is classified as a positive polarity item (+PPI), this interpretation is often treated as non-adult-like, including French (Pagliarini et al., 2022). However, in French both the *exclusive* and the *neither...nor* readings are available to adult speakers (see Section 1.2.1). This means that some children who were previously categorised as non-adult-like may in fact have displayed an adult-like performance. To avoid mislabelling those children, we used simple disjunction as a diagnostic: if a child demonstrated an adult-like *exclusive* interpretation in simple disjunction, any *neither...nor* reading they produced in negated disjunction was treated as adult-like.

The results revealed three main findings. In simple disjunctive statements, three groups emerged, each with a distinct interpretation: *exclusive*, *inclusive*, and *conjunctive* children. About half of the children exhibited the adult-like *exclusive* interpretation, converging towards this reading around age five. Notably, even with the methodological refinements described above, we still observed 16 of 84 children displaying a *conjunctive* preference. In negated disjunctive statements, two main groups were found: *neither...nor* interpreters and *exclusive* interpreters. The proportions of children in each group were approximately similar. Unlike in simple disjunction, these groups did not differ significantly in either size or average age. The *not both* interpretation was notably absent from children's responses. The distribution of response patterns for simple disjunction and negated disjunction is presented in Table 5 and Table 6, respectively.

	Pattern of interpretation			**Inconsistent pattern**
	Exclusive	**Inclusive**	**Conjunctive**	
Children (n = 84)	44 (52.4%)	15 (17.9%)	16 (19%)	9 (10.7%)
Adults (n = 73)	61 (83.6%)	8 (11%)	0 (0%)	4 (5.4%)

Table 5: Number of participants per pattern for **simple disjunction**.

	Pattern of interpretation			**Inconsistent pattern**
	Exclusive	**Not both**	**Neither...nor**	
Children (n = 84)	30 (35.7%)	0 (0%)	40 (47.6%)	14 (16.7%)
Adults (n = 73)	34 (46.6%)	10 (13.7%)	14 (19.2%)	15 (20.5%)

Table 6: Number of participants per pattern for **negated disjunction**.

Combining the results from the two conditions permitted us to identify four types of grammars, illustrated in Table 7. Two of these were categorised as adult-like: the *Complete scale + Wide Scope* grammar (first row) and the *Complete scale + Narrow scope* grammar (second row). The two other grammars were labelled non-adult-like: the *No scalar alternative* grammar (third row) and the *Inclusive + Narrow scope* grammar (fourth row).

Gram.	Insertion of *Exh*	Set of alternatives	Scope	Simple disjunction	Negated disjunction	N
#1	1 round of *Exh*	Complete set $\{P, Q, P \wedge Q\}$	OR > NEG	Exclusive	Exclusive	27/62 (43%)
#2	1 round of *Exh*	Complete set $\{P, Q, P \wedge Q\}$	NEG > OR	Exclusive	Neither...nor	11/62 (18%)
#3	2 rounds of *Exh*	Incomplete set $\{P, Q\}$	NEG > OR OR > NEG	Conjunctive	Neither...nor	16/62 (26%)
#4	No *Exh*	Not relevant	NEG > OR	Inclusive	Neither...nor	8/62 (19%)

Table 7: Predicted patterns for simple and negated disjunction, depending on the nature of the set of alternatives, whether pragmatic enrichment occurred and the scope of disjunction with respect to negation. Gram. = Grammar. Grammars: 1 = *Complete scale + Wide Scope*; 2 = *Complete scale + Narrow scope*; 3 = *No scalar alternative*; 4 = *Inclusive + Narrow scope*

By combining the results across the two disjunctive environments, we concluded that the *neither...nor* interpreters who also derived the *exclusive* interpretation in simple disjunction were in fact adult-like interpreters in disguise. This finding suggests, as we argued in Section 1.2.1 for adults, that children split into two populations with distinct preferences regarding the scope of disjunction relative to negation. Crucially, our design, through the direct comparison across both disjunctive environments, made it possible to distinguish genuine adult-like *neither...nor* readings from non-adult-like ones. Once the non-adult-like *neither...nor* reading was eliminated, the ratio of adult-like *neither...nor* to *exclusive* readings aligned with the adult distribution.

Each of these patterns was predicted to arise under the assumption that children's performance in one context carries over to the other. In particular, we argued that for children who gave a *conjunctive* interpretation in simple disjunction, the *neither...nor* interpretation can be explained regardless of the relative scope of disjunction with negation. These children may genuinely prefer to interpret disjunction below negation, deriving the *neither...nor* reading as per De Morgan's laws. Alternatively, they may interpret disjunction above negation, yielding a *not both* reading that can be pragmatically enriched with respect to an incomplete set of alternatives, deriving a *neither...nor* interpretation. Crucially, children have more than one way to arrive at the *neither...nor* interpretation, explaining why this reading is attested in higher proportions than French adults. Note that (almost) no participants displayed a mismatched pattern such as an *exclusive* reading in negated disjunction paired with either an *inclusive* or a *conjunctive* interpretation in simple disjunction. Taken together, these findings led to the conclusion that children's grammars are consistent across contexts.

Finally, the combination of an *inclusive* reading in simple disjunction with a *not both* interpretation in negated disjunction was not attested. The absence of this pattern can be explained if children display a preference for interpreting disjunction below the scope of negation. In Chapter 3, we proposed that this preference can be modelled under a developmental principle akin to the Semantic Subset Maxim (Notley et al., 2012), which posits an early stage in development where children prefer (though do not necessarily default to) readings that are true in the narrowest range of circumstances. Although this proposal does not encounter the same learnability problems as the Semantic Subset Principle (Crain et al., 1994), it still fails to explain why the *not both* interpretation is entirely absent from our data. We therefore proposed

to attribute children's preference for the *neither...nor* interpretation to a general bias to resolve ignorance entirely. When faced with an ambiguous sentence, children assign the interpretation that eliminates ignorance entirely, namely, the *neither...nor* interpretation. We develop this proposal further in Chapter 5 and is taken up again below in Section 1.3.3.

1.3.2 Children show non-adult-like interpretations of modal disjunctive statements

In Chapter 3, we demonstrated that *neither...nor* responses can arise for both adult-like and non-adult-like reasons, and therefore included an independent diagnostic in the experimental design to tease apart the two analyses. In Chapter 5, we investigated a similar ambiguity in modal disjunctive statements, illustrated in (10). Previous studies have reported that children assign an adult-like reading to such statements, namely the free choice interpretation (10a; Zhou et al. 2013; Tieu et al. 2016; Huang and Crain 2020). We argued, however, that children's alleged free choice interpretation can in fact be mistaken for a *Modal Conjunctive* interpretation (10b). Since children have also been reported to display a non-adult-like *conjunctive* interpretation in simple disjunction, it is plausible that some children produced a reading that looked like free choice, modal conjunction, but actually arose for non-adult-like reasons. Previous studies did not explore this possibility and therefore could not detect it.

(10) Liz can buy a croissant or a donut.
   a. **Free Choice:**
      Liz can buy a croissant and Liz can buy a donut. $\Diamond P \wedge \Diamond Q$
   b. **Modal Conjunction:**
      Liz can buy both a croissant and a donut. $\Diamond(P \wedge Q)$

Critically, although modal conjunction resembles free choice, the two interpretations are not equivalent. Modal conjunction entails the free choice interpretation, but not conversely. Consequently, modal conjunction and free choice share certain verifying and falsifying conditions but they also differ in others. For instance, both interpretations are verified in scenario (11a), and both are falsified in scenario (11b). These were the key conditions tested in previous acquisition studies (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020).

(11) a. **Two disjuncts true:**
      Liz is permitted to buy a croissant and she is permitted to buy a donut. $\Diamond P \wedge \Diamond Q$
   b. **One disjunct true:**
      Liz is permitted to buy a croissant but not a donut. $\Diamond P \wedge \neg\Diamond Q$

In the *Mutually Exclusive* scenario illustrated in (12), however, the modal conjunctive interpretation and the free choice interpretation can be teased apart. In this case, Liz is permitted to buy each disjunct individually (12a). She is however not granted permission to buy both the croissant and the donut (12b). In such a context, while free choice is satisfied because of (12a), modal conjunction is not because of (12b).

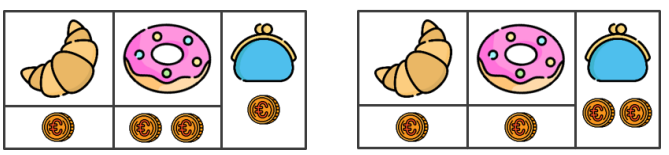
(12) **Mutually Exclusive scenario:**
   a. Liz is permitted to buy a croissant and she is permitted to buy a donut. $\Diamond P \wedge \Diamond Q$
   b. Liz is not permitted to buy both a croissant and a donut. $\neg\Diamond(P \wedge Q)$

In previous studies, the free choice interpretation could not be reliably disentangled from the *Modal Conjunctive* interpretation. As a result, it was premature to conclude that children exhibited an adult-like interpretation, when in fact their responses may have arisen for reasons that are non-adult-like. Extending this reasoning, we hypothesised that learners who assign

a conjunctive reading to simple disjunction may also extend this interpretation to modal disjunction (13).

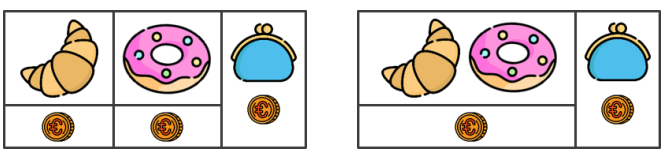
(13) **Extending the learner's conjunctive interpretations to modal disjunction:**
a. Since $(P \vee Q)$ is interpreted as $(P \wedge Q)$
b. It is plausible that $\Diamond(P \vee Q)$ is interpreted as $\Diamond(P \wedge Q)$

To assess whether children derived a genuine *Free Choice* interpretation, we developed a more elaborate setup, adapted from Liu (2019), which allowed us to test a wider range of conditions involving possibility modals. In this setup, participants saw a character with either one or two coins in her purse, alongside two items costing either one or two coins. A shop trainee then uttered a disjunctive statement to describe what the character could buy with the coins available. Participants were asked to judge whether this description was correct or incorrect. In addition to the two conditions replicating the scenarios in (11) (see Figure 1), our design introduced two novel conditions: the *Mutually Exclusive* condition (Figure 2a) and the *Package* (Figure 2b) condition. In the *Mutually Exclusive* condition, the character had the possibility of buying the first disjunct and the possibility of buying the second disjunct, but not both together (i.e., as a package). This condition served primarily to disentangle modal conjunction from free choice, and constituted the key innovation relative to earlier work. To our knowledge, no previous study on the acquisition of (modal) disjunction has employed a design including such a condition.[2] In the *Package* condition, the two disjuncts had to be bought together, as a package. This condition was added to test whether participants derived the optional exclusivity inference.



(a) One Disjunct True **(b)** Two Disjuncts True

Figure 1: Conditions adapting the scenarios in (11).



(a) Mutually Exclusive **(b)** Package

Figure 2: Novel conditions in the coin setup.

To capture not only the observed patterns but also to tease apart the grammar underlying each of them, we developed an analysis structured around three components: (i) whether the *Exh* operator has been inserted, (ii) whether the set of alternatives is complete or lacks the conjunctive alternative, and (iii) whether exhaustification applies globally or locally. Table 8 summarises the interpretations predicted by these combinations, along with the proportion of children who displayed each pattern, which we discuss below.

In contrast to the conclusion of previous studies that children systematically exhibit adult-like behaviour with modal disjunctive statements, our data present a more nuanced picture.

[2] Chemla and Bott (2014), however, designed an adult study featuring a *Mutually Exclusive* context. But this context was not a condition and the exclusivity inference was always satisfied so that it did not interfere with the derivation of the free choice inference.

Interpretation	Insertion of *Exh*	Set of alternatives	Locus of *Exh*	N
Free Choice with Exclusivity	✓	Complete set $\{\Diamond P, \Diamond Q, \Diamond(P \wedge Q)\}$	Global $Exh(Exh(\Diamond(P \vee Q)))$	04/46 (8%)
Free Choice without Exclusivity	✓	Missing conjunction $\{\Diamond P, \Diamond Q\}$	Global $Exh(Exh(\Diamond(P \vee Q)))$	22/46 (48%)
Modal Conjunctive	✓	Missing conjunction $\{\Diamond P, \Diamond Q\}$	Local $\Diamond(Exh(Exh(P \vee Q)))$	10/46 (22%)
Modal Inclusive	×	Not relevant	Not relevant	10/46 (22%)

Table 8: Interpretive patterns in modal disjunction, along with the corresponding grammar (status of pragmatic enrichment, the nature of the set of alternatives, and locus of exhaustification) and the number of children exhibiting each pattern.

We turn first to those children who derived the free choice interpretation (first two rows of Table 8). Only a handful of these children, who derived the *Free Choice with Exclusivity* interpretation (4/46; 8%), were truly adult-like. These children have acquired the ability to perform pragmatic enrichment through insertion of the exhaustification operator and, moreover, know that disjunction and conjunction form a scale.

Most children who displayed the free choice interpretation, however, did so without deriving the additional exclusivity inference (22/46; 48%). Recall from Section 1.2.2 that adults, too, did not always calculate the exclusivity inference (11/36 adults failed to do so). Crucially, though, children did so at a much lower rate. To explain the near absence of this inference, we entertained two alternative explanations. One possibility is that, as proposed for adults, children did derive the inference but subsequently cancelled it. Yet, this explanation alone is insufficient to account for the low derivation rate. For this reason, we proposed that children were able to perform pragmatic enrichment but lacked the conjunctive alternative, thereby yielding a *Free Choice without Exclusivity* interpretation. Importantly, this implies that this interpretation can actually reflect two different grammars, one of which is non-adult-like. Put differently, our analysis extends the group of potentially non-adult-like children with modal disjunctive statements to nearly the entire sample: these children have yet to learn that conjunction belongs on the disjunction scale.

Children who did not calculate the free choice inference or the exclusivity inference were divided between two clear non-adult-like groups: (i) *Modal Inclusive* children (10/46; 22%), and (ii) *Modal Conjunctive* children (10/46; 22%). Without the inclusion of the *Mutually Exclusive* condition in our design, *Modal Conjunctive* children would have been misclassified as free choice interpreters. Each of these two groups received a distinct explanation that we discuss below. Note that these findings were recently corroborated by Bleotu et al. (2024b), who replicated our *Mutually Exclusive* condition, using a different methodology, but critically reporting comparable results.

Accounting for the *Modal Inclusive* interpretation is not straightforward, as it could reflect at least three different grammars. First, the absence of any visible inference may indicate a general inability to insert the *Exh* operator into the structure. Second, as discussed in Chapter 5 (Section 7.3), these children may in fact have exhaustified the disjunctive statement but, in addition to lacking the conjunctive alternative, failed to proceed to a second round of

exhaustification.[3] Third, similar to adults with the exclusivity inference, these children may have cancelled the free choice inference. Since no adult in our data did so, however, this last possibility appeared unlikely.

For the *Modal Conjunctive* interpretation, we proposed that the pragmatic enrichment procedure leading to this interpretation is parallel to Singh et al.'s (2016) account of the *conjunctive* reading in simple (14a) and universally quantified disjunctive statements (14b). Specifically, these children can perform pragmatic enrichment, lack the conjunctive alternative, and insert the *Exh* operator below the modal into the structure, which we referred to as local exhaustification (15a). By contrast, a global exhaustification procedure, illustrated in (15b), in which the *Exh* operator takes scope over the modal disjunctive statement while still lacking the conjunctive alternative, yields a free choice inference without exclusivity. In other words, it is the locus of the exhaustification procedure that determines whether children show a *Free Choice without Exclusivity* interpretation or a *Modal Conjunctive* interpretation.

(14) a. $Exh(Exh(P \vee Q)) \rightsquigarrow (P \wedge Q)$ (Singh et al., 2016)
b. $\forall(Exh(Exh(P \vee Q))) \rightsquigarrow \forall(P \wedge Q)$

(15) a. **Local exhaustification:** $\Diamond(Exh(Exh(P \vee Q))) \rightsquigarrow \Diamond(P \wedge Q)$ § Chapter 5
b. **Global exhaustification:** $Exh(Exh(\Diamond[P \vee Q])) \rightsquigarrow \Diamond P \wedge \Diamond Q$

In sum, our analysis revealed three distinct grammars of modal disjunctive statements, one of which comes in two variants. First, children who performed (global) pragmatic enrichment with a complete set of alternatives derived both the free choice reading and the additional exclusivity inference, exhibiting a truly adult grammar. Second, children who exhibited no visible inference displayed a non-adult-like grammar. Finally, children who have acquired the ability to pragmatically enrich modal disjunctive statements but lacked the conjunctive alternative either exhibited a *Free Choice without Exclusivity* interpretation, if exhaustification occurred globally, or a *Modal Conjunctive* interpretation, if exhaustification occurred locally. Importantly, while previous literature has emphasised the absence of the conjunctive alternative in characterising children's non-adult-like interpretations of disjunction, we have shown that the locality of the enrichment procedure is equally crucial for fully accounting for all observed interpretations of modal disjunctive statements. This fine-grained analysis of the empirical data thus supports a grammatical approach to scalar implicatures, one that critically allows the enrichment procedure to occur at the compositional level rather than only after the entire sentence has been derived, i.e., after syntax.

1.3.3 Children prefer to resolve ignorance as early as possible

Developing the proposal that the *Modal Conjunctive* interpretation arises via local exhaustification raised the question of why children would insert the *Exh* operator locally in the first place. Adopting the grammatical approach made it possible, in Chapter 5, to develop an explanation for why some children would prioritise a parse that leads to a *Modal Conjunctive* interpretation. We argued that these children are particularly sensitive to ignorance inferences like those in (16) and therefore seek to resolve them as early as possible. Within the grammatical approach, the *Exh* operator is a general mechanism that eliminates such inferences by strengthening the meaning of a sentence. In modal disjunction, the free choice inference resolves ignorance about (16a) and (16b), while the exclusivity inference resolves ignorance about (16c). Critically, a

[3] However, as we pointed out in Chapter 5 (Section 7.3), this explanation is only valid in an exhaustification framework that allows for more than one round of exhaustification.

Modal Conjunctive interpretation also resolves all ignorance in (16).

(16) Liz can buy a croissant or a donut.
   a. The speaker does not know whether Liz can buy a croissant.
   b. The speaker does not know whether Liz can buy a donut.
   c. The speaker does not know whether Liz can buy a croissant and a donut.

Importantly, however, a grammar that generates a *Modal Conjunctive* interpretation resolves ignorance inferences earlier than any other grammar. We therefore proposed that children who adopt this interpretation license the insertion of the *Exh* operator differently from adults. Specifically, we adapted Fox's (2007) *Exh* parsing strategy (17) into what we call the *Exh*-low parsing strategy (18), which targets the earliest, smallest constituent generating ignorance inferences during the course of the syntactic derivation.

(17) ***Exh* parsing strategy:** (Fox, 2007)
If a sentence S has an undesirable Ignorance Inference, parse it as $Exh(ALT[S])(S)$.

(18) **Exh-low parsing strategy:**
   a. Take a sentence S.
   b. Take the structurally lowest sub-constituent α of S that generates undesired ignorance inferences.
   c. Append *Exh* to α.

When building the syntactic structure of a modal disjunctive statement, children encounter the disjunctive sub-constituent that generates ignorance inferences. Those children guided by the *Exh*-low parsing strategy insert the *Exh* operator at this point, initiating the pragmatic enrichment procedure, yielding the *Modal Conjunctive* interpretation, as illustrated in Figure 3.

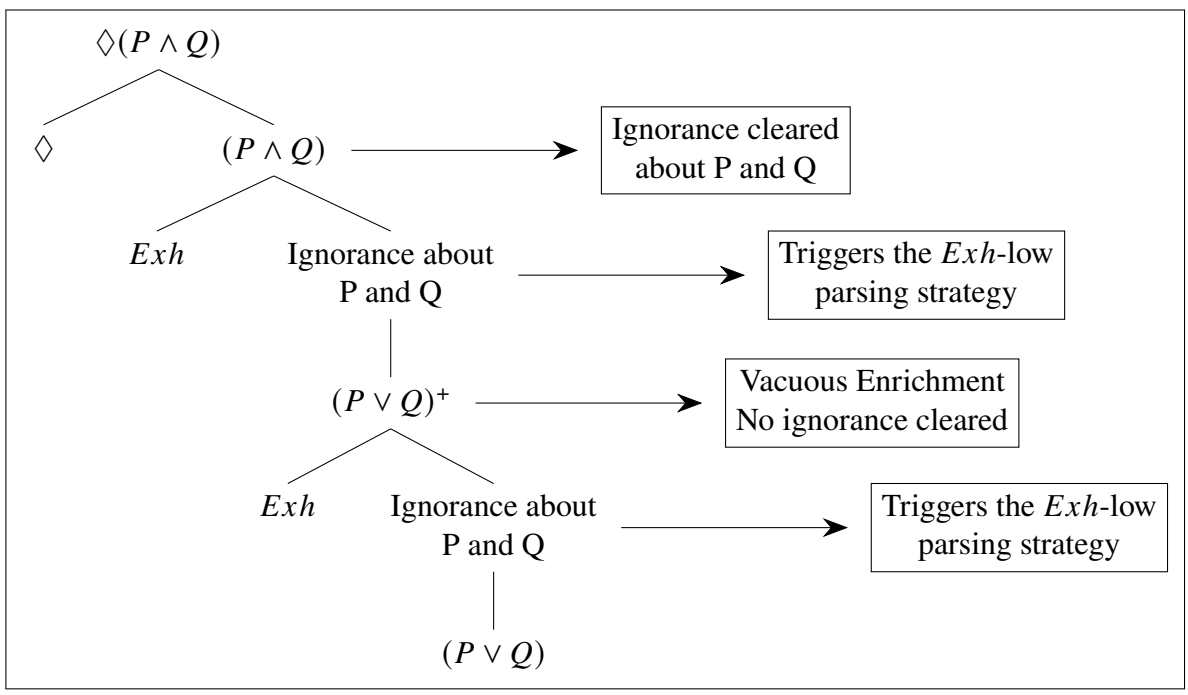


Figure 3: Applying the *Exh*-low parsing strategy.

Overall, the preference for resolving as much ignorance as early as possible extends naturally to other disjunctive contexts. As we speculated in Chapter 3, for simple disjunction, the grammar yielding the *conjunctive* interpretation is the one that eliminates all ignorance. Similarly, for negated disjunction, if disjunction is interpreted above negation, the grammar yielding the *neither...nor* interpretation is also the one that eliminates all ignorance.

2 Sketching the developmental track of disjunction

The theoretical account of children's performance with disjunctive statements suggests three possible grammars. These grammars are characterised by three components: (i) whether the pragmatic enrichment procedure has occurred, and if so, locally or globally; (ii) the gradual acquisition of specific lexical alternatives and the ability to integrate them into scalar reasoning; and (iii) a general preference for resolving as much ignorance as early as possible. Each grammar below yields specific readings for simple disjunction, negated disjunction, and modal disjunction.

Grammar 1: No pragmatic enrichment

The first grammar is characterised by the absence of pragmatic enrichment (i.e. the *Exh* operator has not been inserted into the structure). In simple disjunction, these children are predicted to show an *inclusive* interpretation (19a), while in modal disjunction they should show a modal disjunctive interpretation (19c). Because these children also aim to resolve ignorance as much as possible, they are predicted to prefer the scope configuration that produces the reading eliminating ignorance in negated disjunction, namely enjoining disjunction to scope below negation and yielding a *neither...nor* interpretation (19b).

(19) Expected interpretations for grammar 1:
   a. Simple disjunction: $(P \vee Q)$
   b. Negated disjunction: $(\neg P \wedge \neg Q)$
   c. Modal disjunction: $\Diamond(P \vee Q)$

Grammar 2: Pragmatic enrichment but incomplete set of alternatives

The second grammar corresponds to children who can insert the *Exh* operator in the structure and produce enriched meanings, but fail to generate the adult set of alternatives. Specifically, these children do not generate alternatives that require lexical replacement, that is the conjunctive alternative in the case of disjunction. The resulting set of alternatives thus lacks the conjunctive alternative. In grammar 2, children are predicted to show a *conjunctive* interpretation in simple disjunction (20a) and a *neither...nor* interpretation in negated disjunction (20b). Finally, this grammar comes into two variants for modal disjunction: grammar 2A in which children show a *Modal Conjunctive* interpretation (20c); and grammar 2B in which children are predicted to show a *Free Choice without Exclusivity* interpretation (21c).[4]

[4] A third variant, grammar 2C, is technically possible if children have inserted the *Exh* operator into the structure but fail to proceed to a second round of exhaustification (grammar 2C). As a result, after one round of exhaustification, these children are left with the literal meaning of disjunction as illustrated in (i), assuming they also lack the conjunctive alternative. However, as pointed out in Section 7.3 of Chapter 5, this grammar is only possible in an exhaustification framework where the exclusivity and the free choice inferences arise in separate rounds.

(i) Expected interpretations for grammar 2C:
   a. Simple disjunction: $(P \vee Q)$
   b. Negated disjunction: $(\neg P \vee \neg Q)$ or $\neg P \wedge \neg Q)$
   c. Modal disjunction: $\Diamond(P \vee Q)$

(20) Expected interpretations for grammar 2A:
   a. Simple disjunction: $(P \wedge Q)$
   b. Negated disjunction: $(\neg P \wedge \neg Q)$
   c. Modal disjunction: $\Diamond(P \wedge Q)$

(21) Expected interpretations for grammar 2B:
   a. Simple disjunction: $(P \wedge Q)$
   b. Negated disjunction: $(\neg P \wedge \neg Q)$
   c. Modal disjunction: $\Diamond P \wedge \Diamond Q$

For modal disjunction, the interpretation depends on whether children perform pragmatic strengthening locally (grammar 2A) or globally (grammar 2B). If pragmatic enrichment occurs locally, operating over the disjunctive sub-constituent rather than over the full modal disjunctive statement, children are predicted to derive a *Modal Conjunctive* interpretation. Specifically, these children seek to resolve ignorance as early as possible (see Section 1.3.3). Conversely, if pragmatic enrichment occurs globally children are predicted to derive a *Free Choice without Exclusivity* interpretation.

In the case of negated disjunction, the *neither...nor* reading can arise for three different reasons: (i) children show a preference for the scope configuration generating the reading which eliminates ignorance as in grammar 1; (ii) children interpret disjunction above negation but pragmatically enrich the *not both* interpretation to the *neither...nor* one; or (iii) children have a genuine adult-like preference to interpret disjunction below negation.

Grammar 3: Pragmatic enrichment and complete set of alternatives
The third grammar corresponds to truly adult-like children who can both pragmatically enrich the meaning of disjunctive statements and reason with the full set of alternatives. These children are predicted to show an *exclusive* interpretation in simple disjunction (22a), either an *exclusive* or a *neither...nor* interpretation in negated disjunction (22b), and a *Free Choice with Exclusivity* interpretation in modal disjunction (22c). In negated disjunction, the choice between the *exclusive* and the *neither...nor* reading is determined by whether disjunction is treated as a positive polarity item (scoping above negation) or not (scoping below negation). Table 9 summarizes the predicted interpretations across simple, negated, and modal disjunction contexts for each grammar.

(22) Expected interpretations for grammar 3:
   a. Simple disjunction: $(P \vee Q) \wedge \neg(P \wedge Q)$
   b. Negated disjunction: $(\neg P \vee \neg Q) \wedge \neg(\neg P \wedge \neg Q)$ or $(\neg P \wedge \neg Q)$
   c. Modal disjunction: $(\Diamond P \wedge \Diamond Q) \wedge \neg(\Diamond(P \wedge Q))$

In the course of development, children whose grammar lacks pragmatic enrichment (Grammar 1) are hypothesised to be the younger ones. As children's pragmatic abilities develop, they are expected to progress to grammars 2A and 2B, both characterised by the absence of the scalar alternative in the set of alternatives under consideration. By hypothesis, grammar 2A precedes grammar 2B, though it remains open whether all children pass through this stage. Ultimately, development should converge on Grammar 3, in which children have acquired that disjunction and conjunction form a scale. Our data, however, cannot validate or invalidate this trajectory. Only children who were *exclusive* in simple disjunction were significantly older; no other reliable age effects were observed.

Grammar	Explanation	Simple Disjunction	Negated Disjunction	Modal Disjunction
1	No pragmatic enrichment	Inclusive	Neither...nor NEG > OR	Modal Inclusive
2A	Local pragmatic enrichment but incomplete set of alternatives	Conjunctive	Neither...nor (regardless of scope)	Modal conjunctive ($\Diamond$ > *Exh* > OR)
2B	Global pragmatic enrichment but incomplete set of alternatives	Conjunctive	Neither...nor (regardless of scope)	Free choice without exclusivity (*Exh* > $\Diamond$ > OR)
3	Global pragmatic enrichment and complete set of alternatives	Exclusive	Exclusive (OR > NEG) Neither...nor (NEG > OR)	Free choice with exclusivity

Table 9: Predicted interpretations across simple, negated and modal disjunction contexts.

3 Further outstanding issues for future studies

The results presented in this dissertation opened several promising avenues for future research. This section outlines a set of concrete directions that could advance our understanding of disjunction and its acquisition.

Extension of the current experiments:
Naturally, the results from our experiments need to be replicated. First, the variation observed in French for negated disjunction, with and without prosody, raises the question of whether other languages, such as Italian or Hungarian, two alleged +PPI languages, also show similar variation. If so, this would further call into question the nature of children's interpretation of negated disjunction in those languages. Second, we found that the acquisition of simple and negated disjunction appears to be related. The next step is to examine whether a similar relation holds between simple disjunction and modal disjunction. In particular, just as we used children's performance on simple disjunction as a diagnostic for determining whether the *neither...nor* reading under negation was adult-like, we could likewise use it to assess whether children who show a *Free Choice without Exclusivity* interpretation genuinely lack access to the conjunctive alternative (predicting a *conjunctive* interpretation in simple disjunction), or whether they instead cancel the exclusivity inference, as hypothesised for adults (predicting an *exclusive* interpretation in simple disjunction; see also Section 7.5 from Chapter 5).

Testing disjunction in other negative environments:
Future research should investigate how children and adults interpret disjunction in a wider range of environments beyond the propositional negation tested in this dissertation. This includes disjunctive statements embedded in other inherently negative environments, such as under the negative complementiser *sans* "without" (23a) or the negative word *personne* "nobody" (23b).

(23) a. Liz est rentrée de la boulangerie **sans** (avoir acheté) un croissant **ou** un donut.
"Liz came back from the bakery without (buying) a croissant or a donut."
b. **Personne** (n')a acheté un croissant **ou** un donut.
"Nobody bought a croissant or a donut."

For adults, the question is whether they show the same variation as when disjunction is embedded under propositional negation. Lungu et al.'s (2021) results suggest that this is the case for French. For children, a similar question arises: do they behave uniformly in these environments, or do they exhibit variation? If variation exists, is it similar to that observed in adults? Disjunction in negative environments provides a crucial testing ground for theories of polarity sensitivity and variation. If *sans* and *personne* trigger the same variation as *pas*, this would support a unified account in which all negative operators interact similarly with disjunction. If, however, they differ, this would indicate that the interaction between disjunction and negation is more fine-grained, sensitive to the syntactic or semantic type of the negative operator involved. From a developmental perspective, testing children in these contexts could reveal whether their non-adult-like *neither...nor* preference generalises across different negative environments or is specific to sentential negation.

Testing necessity modal disjunction:
Previous studies, including the one reported in Chapter 5, have consistently tested modal disjunction using possibility modals, paying little attention to other types of modals. We aim to examine another type of modal disjunction: necessity modal disjunction, illustrated in (24).

(24) Liz **doit** nettoyer la cuisine **ou** le salon.
"Liz **must** clean the kitchen **or** the living-room."

Liu (2019), who tested possibility and necessity modal disjunction with Dutch speakers, reported that while speakers readily derived the free choice inference in both modal contexts, they differed for the exclusivity inference. Whereas this inference was treated as optional in possibility modal disjunction, it appeared to be obligatory in necessity modal disjunction. Moreover, Liu (2019) also tested ad-hoc inferences, e.g. forbidding Liz to interact with any other room of the house (25c). Liu (2019) found that whereas speakers did not calculate such inference with possibility modal disjunction, they consistently did for necessity modal disjunction. In sum, possibility and necessity modal disjunction differ on the strength of the additional exclusivity and ad-hoc inferences.

(25) a. **Free Choice inference:**
Liz is allowed to clean the kitchen and she is allowed to clean the living-room.
b. **Exclusivity inference:**
Liz is not required to clean both the kitchen and the living-room.
c. **Ad-hoc inference:**
Liz is not required to clean anything else.

Liu's (2019) finding raises the question of whether children exhibit the same grammar in necessity modal disjunction as in possibility modal disjunction. If they do, we would predict that children show similar patterns of interpretation, particularly the consistent absence of the exclusivity inference. If not, however, what would be the developmental implications? A related question is how children's performance in necessity modal disjunction correlates with the acquisition of necessity modals, given prior findings that children often accept necessity modals in contexts of possibility (Noveck, 2001; Ozturk & Papafragou, 2015; among others)

and do not yet produce them systematically in an adult-like way (Dieuleveut & Noveck, 2025). Finally, ad-hoc inferences provide an especially interesting testing ground for acquisition because, unlike lexical scales, their derivation relies on contextually supplied alternatives for which children are typically adult-like (Stiller et al., 2014; Horowitz et al., 2018; Foppolo et al., 2021).

Role of prosody in shaping interpretation:
Prosody and contextual information can guide adults toward specific interpretations of disjunction, particularly in negated contexts. In Chapter 4, we demonstrated that prosody can guide adults toward the *exclusive* or the *neither...nor* interpretation of negated disjunction. In Chapter 3 and Chapter 5, however, prosody was not manipulated and minimally controlled. We suggest that future studies examine the role of prosody in the acquisition of disjunction in more depth. As is well known, prosody can activate scalar alternatives (Rooth, 1985, 1992), which may help children derive the exclusivity inference.

The development of scales:
A key open question is whether the interpretation of disjunction is tied to a broader developmental pattern that connects with other scalar items, or whether the development of (lexical) scales is item-specific. For example, do children who show an *exclusive* interpretation of disjunction also show the adult-like *some but not all* interpretation of the existential quantifier *some*? The lexicalisation of scales and the ordering of their members are complex processes, and several studies have argued that they pose difficulties for children (Barner et al., 2011; Foppolo et al., 2012, 2021; Singh et al., 2016; Heredia Murillo, 2023), with different scales being acquired at different stages in development. We aim to explore this question in future studies by testing multiple scalar items concurrently within the same design and participant sample.

4 Exploring an alternative to the grammatical approach to scalar implicatures

This dissertation has shown that a group of children consistently exhibit conjunctive-like readings of disjunction in simple disjunctive contexts (26a; Chapter 3; Singh et al. 2016; Paris 1973; Braine and Rumain 1981; Tieu et al. 2017; Cochard et al. 2023; Bleotu et al. 2023), in negated contexts (26b; Chapter 3; Goro 2007; Goro and Akiba 2004; Pagliarini et al. 2022; Geçkin et al. 2018; Cochard et al. 2023) and in modal contexts (26c; Chapter 5; Cochard et al. 2025; Bleotu et al. 2024b). The same observation has also been made for universally quantified disjunction by Singh et al. (2016) (26d).

(26) a. Simple disjunction: $(P \vee Q) \rightsquigarrow (P \wedge Q)$ (Chapter 3)
b. Negated disjunction: $(\neg P \vee \neg Q) \rightsquigarrow (\neg P \wedge \neg Q)$ (Chapter 3)
c. Modal disjunction: $\Diamond(P \vee Q) \rightsquigarrow \Diamond(P \wedge Q)$ (Chapter 5)
d. Universally quantified disjunction: $\forall x(P \vee Q) \rightsquigarrow \forall x(P \wedge Q)$ (Singh et al., 2016)

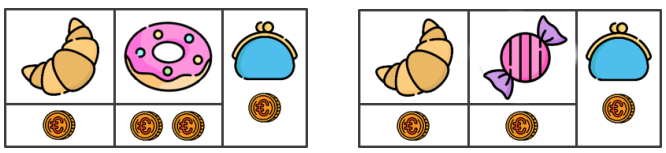
Each of the readings in (26) has been accounted for within the grammatical approach to scalar implicatures, under the assumptions that children know how to apply the exhaustification procedure, do not reason with a complete set of alternatives (lacking the conjunctive alternative), and can insert the *Exh* operator locally due to a preference to resolve ignorance as early as possible. Recently, however, Aloni, Klochowicz, and Sbardolini (2024) have proposed an alternative explanation that does not rely on the grammatical approach, but nevertheless aims

to capture the same range of empirical data.[5] In what follows, we briefly review their proposal and consider how it could be adapted to our coin setup.

The gist of Aloni et al.'s (2024) proposal is that conjunctive-like readings do not arise through scalar implicature reasoning, but rather by the interaction of two cognitive biases: (i) the adult-like Neglect-Zero and (ii) the non-adult-like absence of Split Disjunction, both operative before any form of pragmatic enrichment. Neglect-Zero, which is defined in (27), posits that when evaluating the truth-conditions of a sentence, speakers tend to disregard "zero models", that is, verifying scenarios in which the sentence is true merely by virtue of the absence of relevant elements.

(27) **Neglect-Zero:**
When interpreting a sentence, speakers create mental structures representing reality and in doing so they systematically neglect structures which verify the sentence by virtue of an empty configuration.

For disjunction, zero-models correspond to scenarios in which one disjunct is present but the other is absent or not defined as a viable option. For instance, for the disjunctive statement "Liz bought a croissant or a donut.", a scenario in which Liz bought a croissant without ever having the possibility to buy a donut, perhaps because donuts were too expensive (Figure 4a), or because donuts were out of stock and replaced by candies (Figure 4b)[6], would count as a zero-model verifier.[7]



(a) One Disjunct True **(b)** Absent disjunct

Figure 4: "Zero-models" conditions in the coin setup.

According to Aloni (2022), zero-models are neglected because they are cognitively taxing, a claim supported by empirical evidence on the status of the processing of zero among natural numbers (Nieder, 2016) and downward-monotonic quantifiers processing (Bott et al., 2019). Crucially, the Neglect-Zero bias ensures that disjunctive statements cannot be verified by virtue of a single possibility. For language acquisition, Aloni et al. (2024) posits that Neglect-Zero is acquired early and predict that children, like adults, systematically disregard scenarios like those in Figure 4, where a disjunctive statement is verified solely by virtue of a missing or inaccessible disjunct.

The absence of Split Disjunction is the second bias proposed by Aloni et al. (2024). Split Disjunction, defined in (28) addresses how individual disjuncts are represented as epistemic live possibilities (Aloni, 2022), that is, in addition to the option where both disjuncts are true, each disjunct must be accessible on its own as a separate possibility.

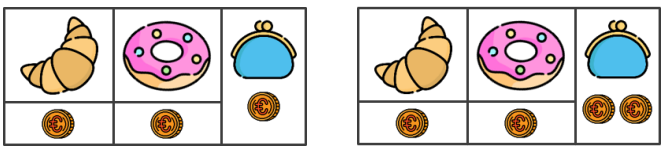
[5] Aloni et al. (2024) model their proposal under the Bilateral State-Based Modal Logic framework (BSML; Aloni 2022; Anttila 2021), which develops a formal account of specific inferences that diverge from both classical semantic entailments and regular conversational implicatures (e.g. free choice inferences). For the purpose of this section, we do not need to introduce BSML further. We refer the reader to Aloni (2022) in which this logic is extensively defined.

[6] Such a condition was not included in our design.

[7] I am highly indebted to Angèle Bernard and Flavia Naehrlich for the illuminating discussion in explaining the framework and elucidating the predictions for each condition of the coin setup.

(28) **Split Disjunction:**
A state S supports a split disjunction $P \vee Q$ iff S is the union of (can be split into) two sub-states, each supporting one of the disjuncts.

For example, for "Liz bought a croissant or a donut", Split Disjunction ensures that it is possible that Liz buys the croissant and it is possible that she buys a donut (Figure 5a), consistently with the possibility she buys both (Figure 5b). The latter case can be negated by calculating an exclusivity inference which Aloni and colleagues assume still arises from regular scalar reasoning.



(a) Mutually Exclusive **(b)** Two Disjuncts True

Figure 5: Conditions satisfying "Split Disjunction" in the coin setup.

Since Split Disjunction requires speakers to evaluate multiple alternatives independently, a cognitively demanding process, Aloni and colleagues propose that this operation emerges only later in development. The absence of Split Disjunction means that disjunctive statements are interpreted as representing a single joint possibility, that is, both disjuncts are true. In our coin setup, the Package condition (Figure 6) would count as a situation compatible with the absence of Split Disjunction. Once children can split disjunction into two independent live possibilities, the only remaining step toward the adult-like interpretation is mastering scalar reasoning.

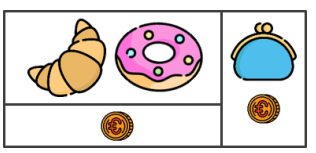


Figure 6: Package condition satisfying the absence of "Split Disjunction" in the coin setup.

Given that Neglect-Zero is assumed to be acquired early, whereas Split Disjunction emerges later, Aloni et al. (2024) and colleagues propose the developmental trajectory shown in (29a). Unlike the trajectory they assume for the grammatical approach in (29b), their model predicts that the *conjunctive* interpretation arises first, immediately followed by the *inclusive* interpretation. However, it is not clear that the trajectory in (29b) they attributed to the grammatical approach is the correct one. Recall from our results that we do not find evidence of an age effect (see also Section 2), in particular regarding which of the *inclusive* or *conjunctive* interpreters are the youngest (but see Lobina et al. 2023a, who report a *conjunctive* interpretation of disjunction in toddlers).

(29) **Developmental trajectory for simple disjunction** (Aloni et al., 2024)
a. Neglect Zero and the absence of Split Disjunction:
Conjunctive > Inclusive > Exclusive
b. Under the grammatical approach:
Inclusive > Conjunctive > Exclusive

De facto, Aloni et al. (2024) predict exactly the patterns observed in our results, making it difficult to empirically distinguish their proposal from the grammatical approach. One advantage of the grammatical approach, however, is that it provides a general characterisation

of scalar implicatures. For instance, our proposal that children resolve ignorance inferences as early as possible, potentially locally in the structure, is testable in other scalar environments. This raises the question for Aloni et al. (2024) whether their proposal can be validated or falsified outside of disjunction, and, if so, how. Only when such predictions are explicitly formulated can the explanatory scope of their model be properly assessed.

5 Last words

We have reached the end of this dissertation. One obvious conclusion is that disjunction is hard. It is hard for children to interpret, and sometimes even for adults. It is hard for the researcher who must design rigorous, yet creative, experimental setups and tasks, and subsequently make sense of the data. Yet, disjunction is also rich: it offers a window into the inner workings of human cognition, linking together logic, language acquisition, semantics, and pragmatics, providing fertile ground for theoretical and empirical investigation. This dissertation has sought to contribute modestly to this richness by expanding the empirical landscape of disjunction, proposing a unified account of children's interpretations of disjunction using the grammatical approach to scalar implicatures and highlighting a novel insight: children proceed to pragmatic enrichment locally, a strategy that we argued stems from a bias to resolve ignorance as much and as early as possible.

With these last words, we close this dissertation in the hope that it has sparked a new interest in solving disjunctive mysteries and in pursuing hand in hand both acquisition and theoretical investigations into the many faces of disjunctive statements, and, more broadly, of logical language.

Appendices

Appendix A

Supplementary material for Chapter 3

Group	Type of statement	Number of disjuncts true	Mean	SD	SE	CI (95%)
Adults	Simple Disjunction	0DT	0.91	9.53	0.64	[-0.35 – 2.17]
		1DT	97.72	14.94	0.71	[96.32 – 99.12]
		2DT	13.01	33.68	1.61	[9.85 – 16.17]
	Negated Disjunction	0DT	47.26	49.98	2.39	[42.56 – 51.96]
		1DT	68.49	46.51	2.22	[64.13 – 72.85]
		2DT	0.46	6.76	0.46	[-0.45 – 1.37]
Children	Simple Disjunction	0DT	3.57	18.59	1.17	[1.27 – 5.87]
		1DT	73.51	44.22	1.97	[69.54 – 77.28]
		2DT	44.84	49.78	2.22	[40.48 – 49.2]
	Negated Disjunction	0DT	61.11	48.80	2.17	[56.85 – 65.37]
		1DT	47.02	49.96	2.23	[42.64 – 51.4]
		2DT	5.56	22.95	1.45	[2.7 – 8.42]

Table A.1: Descriptive statistics for each condition for both adults and children. Numbers are expressed in percentage.

Predictor	**Estimate (β)**	**SE**	z	p
Intercept	−0.18	0.33	−0.54	.587
Simple disjunction	−6.49	0.81	−8.00	$< .001^{***}$
One Disjunct True	1.57	0.60	2.62	$.009^{**}$
Two Disjuncts True	−9.89	1.32	−7.47	$< .001^{***}$
Children	0.99	0.44	2.27	$.02^{*}$
Simple disjunction × One Disjunct True	10.68	0.93	11.48	$< .001^{***}$
Simple disjunction × Two Disjuncts True	11.98	1.43	8.39	$< .001^{***}$
Simple disjunction × Children	0.43	0.89	0.48	.633
One Disjunct True × Children	−2.52	0.80	−3.15	$.002^{**}$
Two Disjuncts True × Children	3.14	1.34	2.34	$.020^{*}$
Simple disjunction × One Disjunct True × Children	−2.43	1.02	−2.38	$.017^{*}$
Simple disjunction × Two Disjuncts True × Children	−0.75	1.53	−0.49	.622

Table A.2: Coefficients for the non-rank deficient model. Formula: *answer* ~ *type_of_disjunction * number_of_disjunct_true * group + (1 + number_of_disjunct_true | participant_id) + (1 | item_id)*

Appendix B

Supplementary material for Chapter 4

Story type	Prosody	Proportion	SD	SE	CI (95%)
Exclusive	OR	70.58	45.56	3.19	6.29
	NEG	29.42			
Neither...nor	OR	16.67	37.26	2.60	5.14
	NEG	83.33			

Table B.1: Descriptive statistics for Figure 10 in Chapter. Numbers are expressed in percentage.

Condition		Mean	SD	SE	CI (95%)
NEG Prosody	One Disjunct True	78.95	40.84	2.34	[74.35 - 83.55]
	No Disjunct True	45.72	49.90	2.86	[40.09 - 51.35]
OR Prosody	One Disjunct True	47.04	49.99	2.87	[41.39 - 52.69]
	No Disjunct True	71.05	45.43	2.61	[65.91 - 76.19]

Table B.2: Descriptive statistics for Figure 18 in Chapter 4, Section 5.2.1. SD = Standard Deviation; SE = Standard Error; CI = Confidence Interval. Numbers express percentages.

Appendix C

Supplementary material for Chapter 5

	Condition	Mean	SD	SE	CI (95%)
Adults	One Disjunct True	1.80	13.33	0.89	[0.05 – 3.55]
	Mutually Exclusive	100.00	0.00	0.00	[100 – 100]
	Package	31.53	46.57	3.13	[25.36 – 37.7]
	Control True	98.20	13.33	0.89	[96.45 – 99.95]
	Control False	0.45	6.71	0.45	[–0.44 – 1.34]
Children	One Disjunct True	27.19	44.56	2.41	[22.45 – 31.93]
	Mutually Exclusive	76.02	42.76	2.31	[71.48 – 80.56]
	Package	81.87	38.58	2.09	[77.76 – 85.98]
	Control True	96.20	19.15	1.04	[94.15 – 98.25]
	Control False	2.05	14.18	0.77	[0.54 – 3.56]

Table C.1: Descriptive statistics for each condition for both adults and children. Numbers are expressed in percentage.

Predictor	**Estimate (β)**	**SE**	z	p
Intercept	−7.32	1.23	−5.96	$< .001^{***}$
Mutually Exclusive	28.03	61.20	0.46	.647
Package	4.73	1.57	3.01	$.003^{**}$
Children	5.06	1.23	4.11	$< .001^{***}$
Mutually Exclusive × Children	−23.22	61.20	−0.38	.704
Package × Children	2.24	2.13	1.05	.295

Table C.2: Coefficients for the unpenalised model. Formula: *answer* ~ *condition* * *group* + *(*1 + *condition* | *participant_id)*

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Summary

This thesis focuses on the developmental challenges of acquiring disjunction ("or") in simple affirmative contexts (1a), under negation (1b), and under a modal expression of possibility (1c), in French-speaking children aged 4 to 8.

(1) a. **Simple disjunction:** Liz bought a croissant **or** a donut.
b. **Negated disjunction:** Liz did **not** buy a croissant **or** a donut.
c. **Modal disjunction:** Liz **can** buy a croissant **or** a donut.

The theoretical and empirical understanding of logical connectives, although carefully investigated in the literature, is still far from complete. In particular, disjunction, the formal characterisation of its associated inferences and their acquisition continue to attract considerable interest. On the one hand, the nature of the reasoning underlying the multiple inferences of a disjunctive sentence is debated on several levels ("what are the relevant alternatives?", "pragmatic or grammatical?", "valid for all linguistic environments or only for certain ones?", etc.). On the other hand, for more than 50 years, it has been known that children have difficulty interpreting disjunctive sentences, showing non-adult-like readings. The diversity of readings allowed by children, as well as those that are not, provide fertile ground for the study of theoretical and empirical questions raised by disjunction.

In doing so, this thesis fulfils two major objectives. First, the three studies presented in this thesis each provide new empirical generalisations on the interpretation of disjunction in children and adults. The results showed that children's performance with disjunctive statements is related in plain affirmative and negative contexts, and that they exhibit interpretations that differ from those of adults in modal disjunction. Furthermore, this thesis has shown that adult data should not be neglected in acquisition studies. In particular, we showed that adult interpretations are more varied than initially assumed, which has a decisive impact on the interpretation of child data. Second, developing the hypothesis that children's responses can be explained by a single unified analysis, this dissertation provides new arguments in favour of the grammatical approach to scalar implicatures. In line with the position defended by Singh et al. (2016), we assume that children have the ability to produce pragmatically enriched meanings by inserting an exhaustification operator into the syntactic structure (*Exh*), but not in the same way as adults. More specifically, in addition to the explanation put forward by Singh et al. (2016) that children have difficulty integrating certain ingredients into their reasoning that allow them to derive the adult reading (e.g., the conjunctive alternative which is necessary to derive the adult exclusive interpretation), we propose that some children insert the exhaustification operator locally, enriching the meaning of a sub-constituent of the sentence rather than the sentence as a whole. To explain this behaviour, we advance that these children have a preference for resolving ignorance inferences, a type of inference licensing the insertion of this operator, as early as possible.

This thesis consists of six chapters, three of which take the form of independent research articles, each focusing on a different research question.

Chapter 2 presents the theoretical framework used in this thesis. In this chapter, we briefly review the extensive literature on scalar implicatures, focusing in particular on disjunction and how to derive its many interpretations. After presenting some general assumptions on disjunction, including its literal meaning, interpretations and alternatives, we present two frameworks that have been used to explain the corresponding inferences: the traditional (neo-)Gricean approach (Grice, 1975, 1989; Gazdar, 1979) and the grammatical approach of scalar implicatures (Kratzer & Shimoyama, 2002; Fox, 2007; Chierchia et al., 2011). In

particular, we detail how the exclusivity (2a) and ignorance (2b) inferences arise, and discuss some specific cases where disjunction receives the truth conditions of conjunction.

(2) a. **Exclusivity:** Liz bought a croissant or a donut, but not both.
b. **Ignorance:** Liz bought a croissant or a donut, but we do not know which.

Chapter 3 presents a study which focuses on the acquisition of disjunction by comparing simple affirmative and negative environments in French. In simple affirmative context (3), numerous studies have shown that children do not produce the adult exclusive reading (3a), either by preserving the literal inclusive meaning of the disjunctive statement (3b) or by attributing to it the truth conditions of conjunction (3c). In negative context (4), the adult reading depends on one parameter: the scopal configuration between disjunction and negation. When disjunction scopes over negation, it yields the "not both" interpretation (4b). This reading can then be pragmatically enriched to derive an exclusive reading (4a). In languages such as Italian, Japanese, Hungarian and, allegedly, French, the exclusive reading is supposed to be the only accessible one. Conversely, when disjunction scopes under negation, only the "neither...nor" interpretation is derived (4c). Languages such as English, Korean and Dutch belong to this category. In the meantime, the majority of acquisition studies show that children aged 4 to 5 years old prefer the "neither...nor..." reading.

(3) Liz bought a croissant or a donut.
a. **Exclusive interpretation:**
Liz bought a croissant or a donut, **but not both.**
b. **Inclusive interpretation:**
Liz bought a croissant or a donut, **possibly both.**
c. **Conjunctive interpretation:**
Liz bought a croissant **and** a donut.

(4) Liz did not buy a croissant or a donut.
a. **Exclusive interpretation:** (OR > NEG + exclusivity inference)
Liz did not buy a croissant or she did not buy a donut, **but not none of them.**
b. **"not both" interpretation:** (OR > NEG)
Liz did not buy a croissant or she did not buy a donut, **possibly none of them.**
c. **"Neither...nor..." interpretation:** (NEG > OR)
Liz bought **neither** a croissant **nor** a donut.

This study was specifically designed to examine these two contexts in parallel in order to determine whether the interpretation patterns observed in affirmative contexts are related to those in negative contexts, thereby shedding light on the mechanisms underlying the development of disjunction in children. The central hypothesis was that children's performance is consistent across contexts (e.g., if a child can generate an exclusive reading in a negative context, they are also expected to generate it in a positive context) and that all possible child grammars can be explained on the basis of three parameters: (i) the presence of the exhaustification operator, (ii) whether the conjunctive alternative has been generated, and (iii) the scope of disjunction for negative contexts. An impossible grammar would assume that children do not reason in the same way in both contexts. This hypothesis is accompanied by a new analysis of the "neither...nor" reading in children. While the traditional analysis, the *Semantic Subset Principle*, assumes that children's first interpretation is the logically strongest one (because it is true in fewer contexts), we propose that the "neither...nor" reading can also

be generated when disjunction is interpreted outside the scope of negation and if children engage in a non-adult-like pragmatic enrichment similar to that responsible for the conjunctive interpretation in simple affirmative contexts.

The study was conducted with 96 French-speaking children aged four to eight, recruited at schools, and 83 French-speaking adults recruited online. By adapting the reward system developed by Goro and Akiba (2004) and addressing methodological issues identified in previous studies (Tieu et al., 2017; Skordos et al., 2020), we designed a truth value judgement task specifically aimed at testing simple and negative disjunctive statements using the same procedure. The interpretation of disjunction was verified by varying the number of true disjuncts in each condition (0, 1, or 2 true disjuncts).

Two main conclusions emerged from the results. First, there were two populations with regard to the interpretation of disjunction under negation. Contrary to expectations from the literature, but in line with our own judgements, French adults fell into two categories: those who interpreted disjunction outside the scope of negation, forming the largest group, and those who interpreted it under the scope of negation. In other words, the "neither...nor" reading is also an adult reading that is just as legitimate as the exclusive reading in French. By using the performance in the simple affirmative context as an indicator of adult or non-adult-like performance, we have shown that among all child "neither...nor" interpreters, a significant proportion of them were in fact exhibiting an adult-like behaviour. Second, the results showed that children's behaviour is consistent from one context to another. Specifically, no child who was exclusive in negative context gave a non-adult-like response in positive context, and all conjunctive children in the simple affirmative context gave a "neither...nor" response in negative context. Finally, we discussed the reasons why a "neither...nor" interpretation might emerge. We showed that the *Semantic Subset Principle* presents a learnability problem: in the absence of positive evidence, the conditions that would allow children to acquire the adult scope configuration are not met. Furthermore, we showed that one of its variants, the *Semantic Subset Maxim*, which assumes that children do have access to both scope configurations but prefer one of them, could not explain why almost no children showed a "not...both" interpretation. Echoing the results of Chapter 5, we speculated that children do have access to both interpretations, but prefer the one that generates the fewest ignorance inferences.

Chapter 4 examines closer the adult interpretation of disjunction under negation. In this chapter, we ask whether one interpretation of disjunction under negation can be favoured over another through prosody. More specifically, we revisit the question of whether the "neither...nor" reading, which is supposedly unavailable in French despite being attested in the study in Chapter 3, is the result of a genuine preference for it or of a disambiguation factor that has not been controlled before, namely prosody. In the literature on the interface between semantics and prosody (Syrett et al., 2014; a.o.), it has been shown that prosody is a decisive factor in resolving the scope configuration of two operators. To investigate this question, we first determined the extent to which a specific interpretation would be associated with a particular prosodic contour. To this end, an experiment was conducted with 40 native French speakers, using a prosodic selection task based on the methodology of van Hout et al. (2024) and adapting the prosodic contours of Surányi and Gulás (2022) to French. We then conducted a second study using a truth value judgement task, in which two groups of 40 adults evaluated negative disjunctive statements uttered with distinct prosodic contours, each group being exposed to a different contour. The results of the first experiment showed that when presented with a context that disambiguates a sentence containing negated disjunctive statement, adults associated an interpretation with a specific prosodic contour. More specifically, when the

context favoured an exclusive reading, adults preferred a prosodic contour where the emphasis was on disjunctive statement itself. Conversely, when the context was disambiguated toward a "neither...nor" reading, adults preferred a prosodic contour where the emphasis was on negation.

The results of the second experiment confirmed the conclusion of the study in Chapter 3 that there are two adult populations of French speakers. For the group exposed to the prosodic contour where emphasis was on disjunction, a majority of participants derived the exclusive reading. For the group exposed to the prosodic contour where the emphasis was on negation, a majority of participants derived the "neither...nor" reading. However, the most important observation is that a subset of participants always showed the interpretation that was not motivated by the prosodic contour to which they were exposed. In other words, these participants have a preference for a particular interpretation regardless of the prosodic contour. To explain this distribution, we have formulated two proposals. On the one hand, we reconsidered the cross-linguistic parameter proposed by Szabolcsi (2002), suggesting that it also applies within the same language, between speakers: some of them treat disjunction as a positive polarity item, necessarily interpreting it outside the scope of negation, while others interpret it without scope constraints. On the other hand, we have suggested that disjunction under negation can be ambiguous between two syntactic structures, phrasal or clausal, and that the chosen prosodic contours may reflect one or the other structure.

Chapter 5 investigates the acquisition of disjunction embedded under a modal expression of possibility (5). Modal disjunction gives rise to a mandatory free choice inference (5a) as well as an optional exclusivity inference (5b).

(5) Liz can buy a croissant or a donut.
   a. **Free Choice:** Liz can buy a croissant and she can buy a donut.
   b. **Exclusivity:** It is not the case that Liz can buy both a croissant and a donut.

The aim of this study was to discuss the conclusion that children derive the free choice inference in the same way as adults (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020). Based on the observation that children have a conjunctive interpretation of disjunction in simple affirmative contexts, we hypothesised that some children produce a modal conjunctive inference (6) from modal disjunction. While the free choice inference and the modal conjunctive one share certain truth conditions, they are not equivalent. In particular, they diverge in mutually exclusive contexts where the two disjuncts cannot be true at the same time.

(6) **Modal conjunctive interpretation:** Liz can buy both a croissant and a donut.

We then show that previous studies cannot distinguish between a free choice interpretation from a modal conjunctive one, leaving open the possibility that some children were prematurely classified as exhibiting adult behaviour. Furthermore, previous work has overlooked another aspect of adult interpretation of disjunctive modal statements: the additional optional exclusivity inference (5b). To address these issues, we designed a new task adapting the lottery machine paradigm from Liu (2019). This task aimed to fulfil a dual purpose: (i) to differentiate between the free choice interpretation and the modal conjunctive one; and (ii) to detect whether the additional exclusivity inference was derived. To this end, the task included a condition where the two disjuncts were mutually exclusive, as well as a condition specifically designed to test the exclusivity inference, where the two disjuncts represent together a single possibility. The experiment was conducted with 68 French speaking children aged four to six recruited at school and 40 French-speaking adults recruited online.

The results showed that, contrary to previous studies, children do not interpret modal disjunction in the same way as adults. Among children who derived a free choice inference, none of them derived an exclusivity inference, unlike adults (two-thirds of whom do so). Among children who did not derive the free choice inference, we identified two non-adult-like groups: one group that produced no inference and only manifested a literal inclusive reading, and another group that produced a modal conjunctive inference. Without the insertion of the mutually exclusive condition, children belonging to the latter group would have been mistakenly considered to derive the free choice inference.

To explain how a modal conjunctive inference is derived, we adopted the grammatical approach to scalar implicatures and proposed that children (i) know how to produce enriched meanings, (ii) do not generate the conjunctive alternative in accordance with the hypothesis of Singh et al. (2016), and (iii) insert the exhaustification operator locally into the syntactic structure, between disjunction and the modal operator. To explain why some children insert this operator earlier than adults into the syntactic structure, we focused on its licensing conditions, and, in particular, on ignorance inferences. We proposed that some children prefer to resolve these inferences as early as possible during meaning composition. In doing so, the exhaustification operator is inserted into the syntactic structure above the first sub-constituent generating an inference of ignorance, i.e. the disjunctive proposition itself.

Finally, Chapter 6 summarises and discusses the main conclusions of the previous three chapters. This chapter also outlines a possible developmental trajectory, presents new directions to explore, and discusses a recent alternative to the grammatical approach for explaining children's conjunctive readings. Throughout the thesis, we have taken every opportunity to highlight the advantages of an experimental approach informed by theory and, in turn, informing the latter further, with the aim of best characterising children's linguistic behaviour. On that last note, we hope that this thesis will have sparked renewed interest in solving disjunctive mysteries and in conducting studies that combine acquisition and theory on the multiple facets of disjunctive utterances and, more generally, logical language.

Résumé

Cette thèse porte sur les enjeux développementaux de l'acquisition de la disjonction ("ou") en contextes affirmatifs simples (1a), sous la négation (1b), et sous une expression modale de possibilité (1c), chez les enfants francophones âgés de 4 à 8 ans.

(1) a. **Disjonction simple :** Liz a acheté un croissant **ou** un donut.
b. **Disjonction sous la négation :** Liz n'a **pas** acheté un croissant **ou** un donut.
c. **Disjonction modale :** Liz **peut** acheter un croissant **ou** un donut.

La compréhension théorique et empirique des connecteurs logiques, bien que soigneusement étudiée, est encore très loin d'être complète. En particulier, la disjonction, la caractérisation formelle des inférences associées et leur acquisition suscitent toujours aujourd'hui un vif intérêt dans la littérature. D'une part, la nature du raisonnement sous-tendant les multiples inférences d'une phrase disjonctive est débattue à plusieurs échelles ("quelles sont les alternatives pertinentes ?", "pragmatique ou grammatical ?", "valable pour tous les environnements linguistique ou seulement pour certains ?", etc.). D'autre part, depuis plus de 50 ans, il est connu que les enfants présentent des difficultés à interpréter les phrases disjonctives, montrant des lectures non-adultes. La diversité des lectures permises par les enfants, ainsi que celles qui ne le sont pas, forment un terrain fertile à l'étude des questions théoriques et empiriques soulevées par la disjonction.

Ce faisant, cette thèse répond à deux objectifs majeurs. Premièrement, les trois études présentées dans cette thèse apportent chacune de nouvelles généralisations empiriques sur l'interprétation de la disjonction, chez les enfants et les adultes. Les résultats présentés dans cette thèse montrent que la performance des enfants en contexte affirmatif et en contexte négatif est liée et que ceux-ci affichent des interprétations différentes de celles des adultes avec la disjonction modale. En outre, cette thèse a montré que les données adultes ne doivent pas être négligées dans les études en acquisition. En particulier, les interprétations des adultes sont plus variées que supposées initialement, ce qui a un impact déterminant sur l'interprétation des données enfantines. Deuxièmement, développant l'hypothèse que les réponses des enfants peuvent être expliquées par une seule analyse unifiée, cette thèse apportent de nouveaux arguments en faveur de l'approche grammaticale des implicatures scalaires. Conformément à la position défendue par Singh et al. (2016), nous supposons que les enfants ont la capacité à produire des significations pragmatiquement enrichies, via l'insertion d'un opérateur d'exhaustification dans la structure syntaxique (*Exh*) mais pas de la même manière que les adultes. Plus précisément, en plus de l'explication portée par Singh et al. (2016) selon laquelle les enfants ont des difficultés à intégrer dans leur raisonnement certains ingrédients permettant de dériver la lecture adulte (par exemple, l'alternative conjonctive nécessaire pour dériver la lecture exclusive), nous proposons dans cette thèse que certains enfants insèrent l'opérateur d'exhaustification localement, enrichissant le sens d'un constituant de la phrase plutôt que cette dernière dans sa totalité. Pour expliquer ce comportement, nous proposons que ces enfants ont une préférence pour résoudre les inférences d'ignorance, un ingrédient légitimant l'insertion de cet opérateur, le plus tôt possible.

Cette thèse est composée de six chapitres, dont trois d'entre eux prennent la forme d'articles de recherche indépendants se concentrant chacun sur une question de recherche différente.

Le Chapitre 2 présente le cadre théorique qui est utilisé dans cette thèse. Dans ce chapitre, nous passons brièvement en revue la vaste littérature sur les implicatures scalaires, en nous concentrant particulièrement sur la disjonction et la manière d'en dériver ses nombreuses interprétations. Après avoir présenté quelques hypothèses générales sur la disjonction,

notamment sa signification littérale, ses interprétations et ses alternatives, nous présentons deux cadres qui ont permis d'expliquer les inférences correspondantes : l'approche traditionnelle (néo-)gricéenne (Grice, 1975, 1989; Gazdar, 1979) et l'approche grammaticale des implicatures scalaires (Kratzer & Shimoyama, 2002; Fox, 2007; Chierchia et al., 2011). Nous détaillons en particulier comment les inférences d'exclusivité (2a) et d'ignorance (2b) apparaissent, et discutons certains cas spécifiques où la disjonction reçoit les conditions de vérité de la conjonction.

(2) a. **Exclusivité :** Liz a acheté un croissant ou un donut, mais pas les deux.
b. **Ignorance :** Liz a acheté un croissant ou un donut, mais on ne sait pas lequel.

Le Chapitre 3 porte sur l'acquisition de la disjonction en comparant les environnements positif et négatifs en français. En contexte positif (3), de nombreuses études ont montré que les enfants ne produisent pas cette inférence la lecture adulte exclusive (3a), soit en préservant le sens littéral inclusif de l'énoncé disjonctif (3b) ou en lui attribuant les conditions de vérité de la conjonction (3c). En contexte négatif (4), la lecture adulte dépend d'un paramètre : la portée de la disjonction par rapport a la négation. Quand la disjonction a la portée sur la négation, c'est l'interprétation "not both" qui est accessible (4b). Cette lecture peut être ensuite pragmatiquement enrichie pour dériver une lecture exclusive (4a). Des langues comme l'italien, le japonais, le hongrois et, prétendument, le français, la lecture exclusive est censée être la seule lecture accessible. A l'inverse, quand la disjonction se trouve dans la portée de la négation, seule l'interprétation "ni...ni..." est accessible (4c). Les langues comme l'anglais, le coréen et le néerlandais appartiennent à cette catégorie. La majorité des études en acquisition montrent que les enfants âgés de 4 à 5 ans préfèrent la lecture "ni...ni...".

(3) Liz a acheté un croissant ou un donut.
a. **Interprétation exclusive :**
Liz a acheté un croissant ou un donut, **mais pas les deux.**
b. **Interprétation inclusive :**
Liz a acheté un croissant ou un donut, **possiblement les deux.**
c. **Interprétation conjonctive :**
Liz a acheté un croissant **et** et un donut.

(4) Liz n'a pas acheté un croissant ou un donut.
a. **Interprétation exclusive :** (OU > NEG + inference d'exclusivité)
Liz n'a pas acheté un croissant ou n'a pas acheté un donut, **mais pas aucun des deux.**
b. **Interprétation "not both" :** (OU > NEG)
Liz n'a pas acheté un croissant ou n'a pas acheté un donut, **possiblement aucun.**
c. **Interprétation "ni...ni..." :** (NEG > OU)
Liz n'acheté **ni** un croissant **ni** un donut.

Cette étude a été spécialement conçue pour examiner ces deux contextes en parallèle afin de déterminer si les schémas d'interprétation observés dans les contextes affirmatifs sont liés à ceux des contextes négatifs, éclairant ainsi les mécanismes qui sous-tendent le développement de la disjonction chez les enfants. L'hypothèse centrale était que (i) la performance des enfants est consistante à travers les contextes (par exemple, si un enfant peut générer la lecture exclusive en contexte négatif, il peut également la générer en contexte positif) et (ii) toutes les grammaires possibles enfantines peuvent être expliquée sur la base de trois paramètres : (i) la

présence de l'opérateur d'exhaustification, (ii) si l'alternative conjonctive a été générée et (iii) la portée de la disjonction pour les contexte négatifs. Une grammaire impossible supposerait que les enfants ne procèdent pas au même raisonnement à travers les deux contextes. Cette hypothèse est accompagnée d'une nouvelle analyse de la lecture "ni...ni..." chez les enfants. Alors que l'analyse traditionnelle, le *Semantic Subset Principle*, consiste à partir du principe que la première interprétation des enfants est celle qui est la plus forte logiquement (car vrai dans moins de contextes), nous proposons que la lecture "ni...ni..." peut aussi être générée si la disjonction est interprétée en dehors de la portée de la négation et que les enfants procèdent à un enrichissement pragmatique non-adulte similaire à celui responsable de la lecture conjonctive en contexte simple.

L'étude a été menée auprès de 96 enfants francophones âgés de quatre à huit ans, recrutés dans leur école, et de 83 adultes francophones recrutés en ligne. En adaptant le système de récompense de Goro and Akiba (2004) et en abordant les questions méthodologiques identifiées dans des études précédentes, nous avons conçu une tâche de jugement de valeur de vérité qui visait spécifiquement à tester des énoncés disjonctifs simples et négatifs en utilisant la même procédure. L'interprétation des énoncés disjonctifs a été vérifiée en faisant varier le nombre de disjoints vrais dans chaque condition (0, 1 ou 2 disjoints vrais).

Deux conclusions principales émergent des résultats. Premièrement, il y a deux populations vis à vis de l'interprétation de la disjonction sous la négation. Contrairement aux attentes de la littérature, mais conformément à nos propres jugements, les adultes français se divisent en deux catégories : ceux qui interprètent la disjonction en dehors de la portée de la négation, formant le groupe le plus important, et ceux qui l'interprètent sous la portée de la négation. Autrement dit, la lecture "ni...ni..." est aussi une lecture adulte tout aussi légitime que la lecture exclusive en français. En utilisant la performance en contexte positif comme un indicateur d'une performance adulte ou non-adulte, nous avons montré que parmi toutes les lectures "ni...ni..." des enfants, une part non-négligeable d'entre elles sont adultes. Deuxièmement, les résultats montrent que le comportement des enfants est consistant d'un contexte à l'autre. En particulier, aucun enfant exclusif en contexte négatif n'a donné de réponse non-adulte en contexte positif, et tous les enfants conjonctifs ont donné une réponse "ni...ni..." en contexte négatif. Enfin, nous avons discuté les raisons pour lesquelles une lecture "ni...ni..." non-adulte peut émerger. Nous avons montré que le *Semantic Subset Principle*, qui suppose que les enfants n'ont accès qu'à une seule configuration de portée, présente un problème d'apprentissage : en l'absence de preuve positive, les conditions qui permettraient à l'enfant d'acquérir la configuration de portée adulte ne sont pas réunies. De plus, nous avons montré que l'une de ses variantes, le *Semantic Subset Maxim*, qui suppose que les enfants ont bien accès aux deux configurations de portée, ne peut pas expliquer pourquoi aucun enfant n'a montré de lecture "not...both". Faisant écho aux résultats du Chapitre 5, nous avons spéculé que les enfants ont bien accès aux deux interprétations, mais préfèrent l'interprétation qui génère le moins d'inférences d'ignorance.

Le Chapitre 4 porte sur l'interprétation adulte de la disjonction sous la négation. Dans l'étude présentée dans ce chapitre, nous nous demandés si une interprétation de la disjonction sous la négation peut être privilégiée par rapport à une autre par le biais de la prosodie. Plus précisément, nous posons à nouveau la question de si la lecture "ni...ni...", prétendument indisponible en français bien qu'attestée dans les résultats de l'étude du Chapitre 3, résulte d'une véritable préférence pour celle-ci ou bien d'un facteur de désambiguïsation qui n'a pas été contrôlé auparavant, à savoir la prosodie. Dans la littérature sur l'interface entre sémantique et prosodie, il a été démontré que cette dernière est un facteur décisif dans la résolution de

la configuration de la portée de deux opérateurs (Syrett et al., 2014). Pour répondre à cette question, nous avons d'abord déterminé dans quelle mesure une interprétation spécifique serait associée à un contour prosodique particulier. À cette fin, une expérience a été menée auprès de 40 locuteurs natifs du français, à l'aide d'une tâche de sélection prosodique utilisant la méthodologie de van Hout et al. (2024) et adaptant les contours prosodiques de Surányi and Gulás (2022) au français. Nous avons ensuite mené une deuxième étude à l'aide d'une tâche de jugement de valeur de vérité, dans laquelle deux groupes de 40 adultes ont évalué des énoncés disjonctifs négatifs produits avec des contours prosodiques distincts, chaque groupe ayant été exposé à un contour différent.

Les résultats de la première expérience ont montré qu'en présence d'un contexte qui désambiguise une phrase comportant une disjonction sous la négation, les adultes associent une interprétation à un contour prosodique spécifique. Plus précisément, lorsque le contexte favorise une lecture exclusive, les adultes préfèrent un contour prosodique où l'accent est mis sur la disjonction elle-même. A l'inverse, lorsque le contexte favorise une lecture "ni...ni...", les adultes préfèrent un contour prosodique où l'accent est porté sur la négation. Les résultats de la seconde expérience viennent confirmer la conclusion de l'étude du Chapitre 3 qu'il y a deux populations de locuteurs en français. Pour le groupe exposé au contour prosodique où l'accent est mis sur la disjonction, une majorité de participants ont dérivé la lecture exclusive. Pour le groupe exposé au contour prosodique où l'accent est mis sur la négation, une majorité de participants ont dérivé la lecture "ni...ni...". Cependant, l'observation la plus importante est qu'un sous-ensemble de participants a toujours montré l'interprétation qui n'était pas motivée par le contour prosodique auquel ils ont été exposés. Autrement dit, ces participants ont une préférence pour une interprétation quelle que soit le contour prosodique. Pour expliquer cette distribution, nous avons formulé deux propositions. D'une part, nous reconsidérons le paramètre interlinguistique proposé par Szabolcsi (2002) en suggérant que celui-ci s'applique aussi au sein d'une même langue, entre les locuteurs : certains traitent la disjonction comme un item de polarité positive, l'interprétant nécessairement en dehors de la portée de la négation, tandis que d'autres l'interprètent sans contrainte de portée. D'autre part, nous avons suggéré que la disjonction sous la négation peut être ambiguë entre deux structures syntaxiques, phrasale ou clausale, et que les contours prosodiques choisis peuvent refléter l'une ou l'autre structure.

Le Chapitre 5 porte sur l'acquisition de la disjonction enchâssée sous une expression modale de possibilité (5). La disjonction modale donne lieu à une inférence de libre choix obligatoire (5a) ainsi qu'une à une inférence d'exclusivité optionnelle (5b).

(5) Liz peut acheter un croissant ou un donut.
   a. **Libre choix :** Liz peut acheter un croissant et elle peut acheter un donut.
   b. **Exclusivité :** Ce n'est pas le cas que Liz peut acheter un croissant et un donut.

L'objectif de cette étude était de discuter la conclusion selon laquelle les enfants dérivent l'inférence du libre choix comme les adultes (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020). En nous appuyant sur l'observation que les enfants ont une interprétation conjonctive de la disjonction en contexte simple affirmatif, nous avons émis l'hypothèse que les enfants font une inférence conjonctive modale (6) avec la disjonction modale. L'inférence de libre-choix et l'inférence conjonctive modale partagent certaines conditions de vérité, mais ne sont pas équivalentes. En particulier, elles divergent dans les contextes mutuellement exclusifs où les deux disjoints ne peuvent être vrais en même temps.

(6) **Interprétation conjonctive modale :** Liz peut acheter un croissant et un donut.

Nous montrons ensuite que les études précédentes ne peuvent pas faire la distinction entre une interprétation de libre-choix et une interprétation conjonctive modale, laissant ainsi ouverte la possibilité que certains enfants aient été prématurément classés comme ayant un comportement adulte. De plus, les travaux précédents ont négligé un autre aspect de l'interprétation adulte des énoncés disjonctifs modaux : l'inférence d'exclusivité supplémentaire (5b). Pour remédier à ces problèmes, nous avons conçu une nouvelle tâche, en adaptant le paradigme de la machine de loterie de Liu (2019). La tâche ainsi développée visait à remplir un double objectif : (i) différencier l'interprétation de libre-choix de l'interprétation conjonctive modale ; et (ii) à détecter si l'inférence d'exclusivité supplémentaire était dérivée. À cette fin, la tâche comprenait une condition où les deux disjoints sont mutuellement exclusifs, ainsi qu'une condition spécialement conçue pour tester l'inférence d'exclusivité, où les deux disjoints représentent ensemble une seule et même possibilité. L'expérience a été menée auprès de 68 enfants francophones âgés de quatre à six ans recrutés à l'école et de 40 adultes francophones recrutés en ligne.

Les résultats ont montré que, contrairement aux études précédentes, les enfants n'interprètent pas la disjonction modale comme les adultes. Parmi les enfants qui dérivent une inférence de libre-choix, aucun ne dérive l'inférence d'exclusivité contrairement aux adultes qui le font pour les deux-tiers d'entre eux. Parmi les enfants qui ne dérivent pas l'inférence de libre-choix, nous avons identifié deux groupes non-adultes : un groupe qui ne produit aucune inférence et manifeste uniquement la lecture littérale inclusive, et un groupe qui produit une inférence conjonctive modale. Sans l'insertion de la condition mutuellement exclusive, les enfants appartement à ce dernier groupe auraient été considérés, à tord, comme dérivant l'inférence de libre-choix.

Pour expliquer comment l'inférence conjonctive modale est dérivée, nous avons adopté l'approche grammaticale des implicatures scalaires et proposé que les enfants (i) savent produire des significations enrichies, (ii) ne génèrent pas l'alternative conjonctive conformément à l'hypothèse de Singh et al. (2016) et (iii) insèrent l'opérateur d'exhaustification localement dans la structure syntaxique, entre la disjonction et l'expression modale. Pour expliquer pourquoi certains enfants insèrent cet opérateur plus tôt que les adultes dans la structure syntaxique, nous nous sommes concentrés sur les conditions de licenciement de celui-ci et en particulier sur les inférences d'ignorance. Nous avons proposé que certains enfants préfèrent résoudre ces inférences le plus tôt possible durant la composition du sens. Ce faisant, l'opérateur d'exhaustification est inséré dans la structure syntaxique au dessus du premier sous-constituant générant une inférence d'ignorance, c'est à dire la proposition disjonctive elle même.

Enfin, le Chapitre 6 résume et discute les principales conclusions des trois chapitres précédents. Ce chapitre esquisse également une trajectoire développementale possible, présente de nouvelles directions à explorer et discute une récente alternative à l'approche grammaticale pour expliquer les lectures conjonctives enfantines. Tout au long de la thèse, nous avons profité de toutes les occasions possibles pour souligner les avantages d'une approche expérimentale informée par la théorie et l'informant davantage en retour, dans le but de caractériser au mieux le comportement linguistique des enfants. Sur ces derniers mots, nous espérons que cette thèse aura suscité un nouvel intérêt pour la résolution des mystères disjonctifs et pour la conduite d'études mêlant acquisition et théorie sur les multiples facettes des énoncés disjonctifs, et plus généralement, du langage logique.

Samenvatting

Deze thesis richt zich op de ontwikkelingsuitdagingen bij het verwerven van disjunctie ("of") in eenvoudige bevestigende contexten (1a), onder ontkenning (1b) en onder een modale uitdrukking van mogelijkheid (1c) bij Franstalige kinderen van 4 tot 8 jaar.

(1) a. **Eenvoudige disjunctie:** Liz kocht een croissant **of** een donut.
b. **Negatieve disjunctie:** Liz heeft **geen** croissant **of** donut gekocht.
c. **Modale disjunctie:** Liz **kan** een croissant **of** een donut kopen.

Het theoretische en empirische begrip van logische connectieven, hoewel zorgvuldig onderzocht in de literatuur, is nog lang niet volledig. Met name disjunctie, de formele karakterisering van de daarmee samenhangende gevolgtrekkingen en de verwerving daarvan blijven veel belangstelling trekken. Enerzijds wordt op verschillende niveaus gediscussieerd over de aard van het redeneren dat ten grondslag ligt aan de meervoudige gevolgtrekkingen van een disjunctieve zin ("wat zijn de relevante alternatieven?", "is dit pragmatisch of grammaticaal?", "is dit geldig voor alle taalomgevingen of alleen voor bepaalde?", enz.). Anderzijds is al meer dan 50 jaar bekend dat kinderen moeite hebben met het interpreteren van disjunctieve zinnen en dat zij deze op een andere manier lezen dan volwassenen. De diversiteit aan interpretaties die kinderen toestaan, evenals de diversiteit van de interpretaties die zij niet toestaan, vormt een vruchtbare bodem voor de studie van theoretische en empirische vragen die door disjunctie worden opgeworpen.

Hiermee vervult dit proefschrift twee belangrijke doelstellingen. Ten eerste bieden de drie studies die in dit proefschrift worden gepresenteerd elk nieuwe empirische generalisaties over de interpretatie van disjunctie bij kinderen en volwassenen. De resultaten tonen aan dat de prestaties van kinderen met disjunctieve uitspraken verband houden met duidelijke bevestigende en ontkennende contexten, en dat zij interpretaties vertonen die verschillen van die van volwassenen in modale disjunctie. Verder heeft dit proefschrift aangetoond dat gegevens van volwassenen niet mogen worden verwaarloosd in onderzoek naar taalverwerving. We hebben met name aangetoond dat de interpretaties van volwassenen gevarieerder zijn dan aanvankelijk werd aangenomen, wat een beslissende invloed heeft op de interpretatie van gegevens van kinderen. Ten tweede, door de hypothese te ontwikkelen dat de reacties van kinderen kunnen worden verklaard door één enkele uniforme analyse, levert dit proefschrift nieuwe argumenten ten gunste van de grammaticale benadering van scalaire implicaties. In overeenstemming met het standpunt van Singh et al. (2016) gaan we ervan uit dat kinderen het vermogen hebben om pragmatisch verrijkte betekenissen te produceren door een exhaustificatieoperator in de syntactische structuur (Exh) in te voegen, maar niet op dezelfde manier als volwassenen. Meer specifiek stellen we, naast de verklaring van Singh et al. (2016) dat kinderen moeite hebben om bepaalde ingrediënten in hun redenering te integreren die hen in staat stellen de volwassen interpretatie af te leiden (bijvoorbeeld het conjunctieve alternatief dat nodig is om de volwassen exclusieve interpretatie af te leiden), dat sommige kinderen de exhaustificatieoperator lokaal invoegen, waardoor de betekenis van een subconstituent van de zin wordt verrijkt in plaats van de zin als geheel. Om dit gedrag te verklaren, stellen we dat deze kinderen de voorkeur geven aan het zo vroeg mogelijk oplossen van onwetendheidsinferenties, een type inferentie dat het invoegen van deze operator toestaat.

Dit proefschrift bestaat uit zes hoofdstukken, waarvan er drie de vorm hebben van onafhankelijke onderzoeksartikelen, elk gericht op een andere onderzoeksvraag.

Hoofdstuk 2 presenteert het theoretische kader dat in dit proefschrift wordt gebruikt. In dit hoofdstuk geven we een kort overzicht van de uitgebreide literatuur over scalaire implicaties,

waarbij we ons in het bijzonder richten op disjunctie en hoe de vele interpretaties daarvan kunnen worden afgeleid. Na enkele algemene aannames over disjunctie te hebben gepresenteerd, waaronder de letterlijke betekenis, interpretaties en alternatieven, presenteren we twee kaders die zijn gebruikt om de bijbehorende gevolgtrekkingen te verklaren: de traditionele (neo-)Griceaanse benadering (Grice, 1975, 1989; Gazdar, 1979) en de grammaticale benadering van scalaire implicaties (Kratzer & Shimoyama, 2002; Fox, 2007; Chierchia et al., 2011). In het bijzonder beschrijven we hoe de inferenties van exclusiviteit (2a) en onwetendheid (2b) ontstaan, en bespreken we enkele specifieke gevallen waarin disjunctie de waarheidscondities van conjunctie krijgt.

(2) a. **Exclusiviteit:** Liz kocht een croissant of een donut, maar niet beide.
b. **Onwetendheid:** Liz kocht een croissant of een donut, maar we weten niet welke.

Hoofdstuk 3 presenteert een studie die zich richt op het verwerven van disjunctie door eenvoudige bevestigende en ontkennende contexten in het Frans te vergelijken. In eenvoudige bevestigende contexten (3) hebben talrijke studies aangetoond dat kinderen niet de exclusieve interpretatie van volwassenen (3a) produceren, maar ofwel de letterlijke inclusieve betekenis van de disjunctieve uitspraak (3b) behouden, ofwel er de waarheidsvoorwaarden van conjunctie (3c) aan toekennen. In een negatieve context (4) hangt de interpretatie van volwassenen af van één parameter: de bereiksconfiguratie tussen disjunctie en negatie. Wanneer disjunctie bereik heeft over de negatie, levert dit de interpretatie 'niet beide' op (4b). Deze interpretatie kan vervolgens pragmatisch worden verrijkt om een exclusieve interpretatie af te leiden (4a). In talen zoals het Italiaans, Japans, Hongaars en, naar verluidt, Frans, zou de exclusieve interpretatie de enige toegankelijke zijn. Omgekeerd, wanneer disjunctie onder negatie valt, wordt alleen de interpretatie 'noch...noch' afgeleid (4c). Talen zoals Engels, Koreaans en Nederlands behoren tot deze categorie. Ondertussen toont het meeste onderzoek naar taalverwerving aan dat kinderen van 4 tot 5 jaar de voorkeur geven aan de 'noch...noch'-lezing.

(3) Liz kocht een croissant of een donut.
a. **Exclusieve interpretatie:**
Liz kocht een croissant of een donut, **maar niet beide**.
b. **Inclusieve interpretatie:**
Liz kocht een croissant of een donut, **mogelijk beide.**
c. **Conjunctieve interpretatie:**
Liz kocht een croissant **en** een donut.

(4) Liz heeft geen croissant of donut gekocht.
a. **Exclusieve interpretatie:** (OF > NIET + exclusiviteitsreferentie)
Liz kocht niet een croissant of een donut, **maar niet geen van beide**.
b. **Interpretatie "niet beide":** (OF > NIET)
Liz kocht niet een croissant of een donut, **mogelijk geen van beide.**
c. **"Noch... noch..." interpretatie:** (NIET > OF)
Liz **noch** een croissant, **noch** een donut gekocht.

Deze studie was specifiek ontworpen om deze twee contexten parallel te onderzoeken om te bepalen of de interpretatiepatronen die in bevestigende contexten worden waargenomen, verband houden met die in negatieve contexten, en zo licht te werpen op de mechanismen die ten grondslag liggen aan de ontwikkeling van disjunctie bij kinderen. De centrale hypothese was dat de prestaties van kinderen consistent zijn in alle contexten (bijvoorbeeld

als een kind een exclusieve interpretatie kan genereren in een negatieve context, dan wordt verwacht dat het dit ook kan in een positieve context) en dat alle mogelijke grammatica's van kinderen kunnen worden verklaard op basis van drie parameters: (i) de aanwezigheid van de exhaustificatieoperator, (ii) of het conjunctieve alternatief is gegenereerd, en (iii) het bereik van disjunctie in negatieve contexten. Een onmogelijke grammatica zou veronderstellen dat kinderen in beide contexten niet op dezelfde manier redeneren. Deze hypothese gaat gepaard met een nieuwe analyse van de "noch...noch"-interpretatie bij kinderen. Terwijl de traditionele analyse, het Semantic Subset Principle, ervan uitgaat dat de eerste interpretatie van kinderen de logisch sterkste is (omdat deze in minder contexten waar is), stellen wij dat de "noch...noch"-interpretatie ook ontstaat wanneer disjunctie buiten het bereik van negatie wordt geïnterpreteerd en wanneer kinderen een pragmatische verrijking toepassen die voor volwassenen niet beschikbaar is die vergelijkbaar is met de verrijking die verantwoordelijk is voor de conjunctieve interpretatie in eenvoudige bevestigende contexten.

Het onderzoek werd uitgevoerd met 96 Franstalige kinderen van vier tot acht jaar, gerekruteerd op scholen, en 83 Franstalige volwassenen, gerekruteerd via internet. Door het beloningssysteem van Goro en Akiba (2004) aan te passen en methodologische kwesties aan te pakken die in eerdere studies waren vastgesteld (Tieu et al., 2017; Skordos et al., 2020), hebben we een taak voor het beoordelen van waarheidswaarden ontworpen die specifiek gericht is op het testen van eenvoudige en negatieve disjunctieve uitspraken met behulp van dezelfde procedure. De interpretatie van disjunctie werd geverifieerd door het aantal ware disjuncten in elke conditie te variëren (0, 1 of 2 ware disjuncten).

Uit de resultaten kwamen twee belangrijke conclusies naar voren. Ten eerste waren er twee groepen wat betreft de interpretatie van disjunctie onder negatie. In tegenstelling tot wat op basis van de literatuur werd verwacht, maar in overeenstemming met ons eigen oordeel, konden Franse volwassenen in twee categorieën worden ingedeeld: degenen die disjunctie buiten het bereik van negatie interpreteerden, die de grootste groep vormden, en degenen die de disjunctie onder het bereik van negatie interpreteerden. Met andere woorden, de interpretatie 'noch... noch' is ook een volwassen interpretatie die net zo legitiem is als de exclusieve interpretatie in het Frans. Door de prestaties in de eenvoudige bevestigende context te gebruiken als indicator voor volwassen of niet-volwassen prestaties, hebben we aangetoond dat een aanzienlijk deel van alle kinderen die 'noch... noch' interpreteerden, in feite volwassen gedrag vertoonden. Ten tweede toonden de resultaten aan dat het gedrag van kinderen consistent is van de ene context naar de andere. Specifieker, geen enkel kind dat een exclusieve interpretatie had in de negatieve context, gaf een niet-volwassen antwoord in de positieve context, en alle kinderen met een conjunctieve interpretatie in de eenvoudige bevestigende context gaven een 'noch... noch'-reactie in de negatieve context. Ten slotte bespraken we de redenen waarom een 'noch... noch'-interpretatie zou kunnen ontstaan. We toonden aan dat het Semantic Subset Principle een leerbaarheidsprobleem oplevert: bij gebrek aan positief bewijs is niet voldaan aan de voorwaarden waaronder kinderen de volwassen bereiksconfiguratie zouden kunnen verwerven. Bovendien hebben we aangetoond dat een van de varianten ervan, de Semantische Subset Maxim, die ervan uitgaat dat kinderen wel toegang hebben tot beide bereiksconfiguraties, maar de voorkeur geven aan een van beide, niet kon verklaren waarom bijna geen enkel kind een 'niet beide'-interpretatie gaf. In navolging van de resultaten van hoofdstuk 5 hebben we gespeculeerd dat kinderen wel toegang hebben tot beide interpretaties, maar de voorkeur geven aan de interpretatie die de minste onwetendheidsconclusies oplevert.

Hoofdstuk 4 gaat dieper in op de interpretatie van volwassenen van disjunctie onder negatie. In dit hoofdstuk vragen we ons af of de ene interpretatie van disjunctie onder negatie via

prosodie de voorkeur kan krijgen boven de andere. Meer specifiek komen we terug op de vraag of de interpretatie 'noch...noch', die in het Frans zogenaamd niet mogelijk is, hoewel het bestaan hiervan in het onderzoek in hoofdstuk 3 wordt bevestigd, het resultaat is van een echte voorkeur hiervoor of van een verstorende factor waarvoor nog niet eerder is gecontroleerd, namelijk prosodie. In de literatuur over het raakvlak tussen semantiek en prosodie (Syrett et al., 2014; i.a.) is aangetoond dat prosodie een doorslaggevende factor is bij het oplossen van de bereiksconfiguratie van twee operatoren. Om deze vraag te onderzoeken, hebben we eerst bepaald in hoeverre een specifieke interpretatie zou worden geassocieerd met een bepaalde prosodische contour. Daartoe werd een experiment uitgevoerd met 40 moedertaalsprekers van het Frans, waarbij gebruik werd gemaakt van een prosodische selectietaak op basis van de methodologie van van Hout et al. (2024) en waarbij de prosodische contouren van Surányi en Gulás (2022) werden aangepast aan het Frans. Vervolgens hebben we een tweede onderzoek uitgevoerd met behulp van een waarheidswaardebeoordelingstaak, waarbij twee groepen van 40 volwassenen negatieve disjunctieve uitspraken met verschillende prosodische contouren beoordeelden, waarbij elke groep werd blootgesteld aan een andere contour. De resultaten van het eerste experiment toonden aan dat volwassenen, wanneer ze werden geconfronteerd met een context die een zin met een ontkende disjunctieve uitspraak ondubbelzinnig maakt, een interpretatie koppelden aan een specifieke prosodische contour. Meer specifiek, wanneer de context een exclusieve interpretatie bevorderde, gaven volwassenen de voorkeur aan een prosodische contour waarbij de nadruk lag op de disjunctieve uitspraak zelf. Omgekeerd, wanneer de context ondubbelzinnig was in de richting van een 'noch...noch'-interpretatie, gaven volwassenen de voorkeur aan een prosodische contour waarbij de nadruk lag op de ontkenning.

De resultaten van het tweede experiment bevestigden de conclusie van het onderzoek in hoofdstuk 3 dat er twee volwassen populaties Franstaligen zijn. Voor de groep die werd blootgesteld aan de prosodische contour waarbij de nadruk lag op disjunctie, leidde een meerderheid van de deelnemers de exclusieve interpretatie af. Voor de groep die werd blootgesteld aan de prosodische contour waarbij de nadruk lag op negatie, leidde een meerderheid van de deelnemers de interpretatie 'noch... noch' af. De belangrijkste observatie is echter dat een deel van de deelnemers altijd de interpretatie gaf die niet werd gemotiveerd door de prosodische contour waaraan ze waren blootgesteld. Met andere woorden, deze deelnemers hebben een voorkeur voor een bepaalde interpretatie, ongeacht de prosodische contour. Om deze verdeling te verklaren, hebben we twee voorstellen geformuleerd. Enerzijds hebben we de door Szabolcsi (2002) voorgestelde cross-linguïstische parameter heroverwogen en gesuggereerd dat deze ook binnen dezelfde taal van toepassing is, tussen sprekers: sommigen van hen behandelen disjunctie als een positief polariteitsitem en interpreteren het noodzakelijkerwijs buiten het bereik van ontkenning, terwijl anderen het interpreteren zonder bereikbeperkingen. Anderzijds hebben we gesuggereerd dat disjunctie onder ontkenning ambigu kan zijn tussen twee syntactische structuren, op het niveau van de woordgroep of van de deelzin, en dat de gekozen prosodische contouren de ene of de andere structuur kunnen weerspiegelen.

(5) Liz kan een croissant of een donut kopen.
   a. **Vrije keuze:** Liz kan een croissant kopen en ze kan een donut kopen.
   b. **Exclusiviteit:** Het is niet zo dat Liz zowel een croissant als een donut kan kopen.

Hoofdstuk 5 onderzoekt de verwerving van disjunctie ingebed onder een modale uitdrukking van mogelijkheid (5). Modale disjunctie geeft aanleiding tot een verplichte vrije keuze-inferentie (5a) en een optionele exclusiviteits-inferentie (5b).

Het doel van deze studie was om de conclusie te bespreken dat kinderen op dezelfde manier als volwassenen de vrije keuze-inferentie afleiden (Zhou et al., 2013; Tieu et al., 2016; Huang & Crain, 2020). Op basis van de observatie dat kinderen een conjunctieve interpretatie hebben van disjunctie in eenvoudige bevestigende contexten, hebben we de hypothese opgesteld dat sommige kinderen een modale conjunctieve gevolgtrekking maken (6) op basis van modale disjunctie. Hoewel de vrije keuze-inferentie en de modale conjunctieve inferentie bepaalde waarheidsvoorwaarden delen, zijn ze niet equivalent. Ze verschillen met name in wederzijds-exclusieve contexten, waar de twee disjuncties niet tegelijkertijd waar kunnen zijn.

(6) **Modale conjunctieve interpretatie:** Liz kan zowel een croissant als een donut kopen.

Vervolgens tonen we aan dat eerdere studies geen onderscheid kunnen maken tussen een vrije keuzeinterpretatie en een modale conjunctieve interpretatie, waardoor de mogelijkheid openblijft dat sommige kinderen voortijdig werden geclassificeerd als kinderen die volwassen gedrag vertonen. Bovendien hebben eerdere studies een ander aspect van de volwassen interpretatie van disjunctieve modale uitspraken over het hoofd gezien: de aanvullende optionele exclusiviteitsinferentie (5b). Om deze kwesties aan te pakken, hebben we een nieuwe taak ontworpen waarin we het loterijmachineparadigma van Liu (2019) hebben aangepast. Deze taak had een tweeledig doel: (i) onderscheid maken tussen de vrije keuzeinterpretatie en de modale conjunctieve interpretatie; en (ii) detecteren of de aanvullende exclusiviteitsinferentie werd afgeleid. Daartoe omvatte de taak een voorwaarde waarbij de twee disjuncten elkaar wederzijds uitsloten, evenals een voorwaarde die specifiek was ontworpen om de exclusiviteitsinferentie te testen, waarbij de twee disjuncten samen één enkele mogelijkheid vertegenwoordigen. Het experiment werd uitgevoerd met 68 Franstalige kinderen van vier tot zes jaar die op school waren gerekruteerd en 40 Franstalige volwassenen die online waren gerekruteerd.

De resultaten toonden aan dat, in tegenstelling tot eerdere studies, kinderen modale disjunctie niet op dezelfde manier interpreteren als volwassenen. Van de kinderen die een vrije keuze-inferentie afleidden, leidde geen van hen een exclusiviteitsinferentie af, in tegenstelling tot volwassenen (van wie tweederde dat wel doet). Onder de kinderen die geen vrije keuze-inferentie trokken, identificeerden we twee groepen die niet op volwassenen leken: een groep die geen conclusie trok en alleen een letterlijke inclusieve interpretatie gaf, en een andere groep die een modale conjunctieve conclusie trok. Zonder de toevoeging van de wederzijds exclusieve voorwaarde zouden kinderen uit de laatste groep ten onrechte zijn beschouwd als kinderen die een vrije keuze-inferentie trokken. Om uit te leggen hoe een modale conjunctieve inferentie wordt afgeleid, hebben we de grammaticale benadering van scalaire implicaties toegepast en voorgesteld dat kinderen (i) weten hoe ze verrijkte betekenissen kunnen produceren, (ii) het conjunctieve alternatief niet genereren in overeenstemming met de hypothese van Singh et al. (2016), en (iii) de exhaustificatieoperator lokaal in de syntactische structuur invoegen, tussen disjunctie en de modale operator. Om uit te leggen waarom sommige kinderen deze operator eerder in de syntactische structuur invoegen dan volwassenen, hebben we ons gericht op de licentiëringsvoorwaarden ervan, en in het bijzonder op onwetendheidsinferenties. We stelden voor dat sommige kinderen er de voorkeur aan geven deze inferenties zo vroeg mogelijk tijdens de betekeniscompositie op te lossen. Daarbij wordt de exhaustificatieoperator ingevoegd in de syntactische structuur boven de eerste subconstituent die een inferentie van onwetendheid genereert, d.w.z. de disjunctieve propositie zelf.

Ten slotte worden in hoofdstuk 6 de belangrijkste conclusies van de voorgaande drie hoofdstukken samengevat en besproken. Dit hoofdstuk schetst ook een mogelijk ontwikkelings-

traject, presenteert nieuwe richtingen om te verkennen en bespreekt een recent alternatief voor de grammaticale benadering om de conjunctieve interpretaties van kinderen te verklaren. In het hele proefschrift hebben we elke gelegenheid aangegrepen om de voordelen te benadrukken van een experimentele benadering die is gebaseerd op theorie en die op haar beurt weer bijdraagt aan die theorie, met als doel het taalgedrag van kinderen zo goed mogelijk te karakteriseren. Wat dat laatste betreft, hopen we dat dit proefschrift nieuwe belangstelling heeft gewekt voor het oplossen van disjunctieve mysteries en voor het uitvoeren van studies die verwerving en theorie combineren over de vele facetten van disjunctieve uitingen en, meer in het algemeen, logische taal.

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Titre : Acquérir les Nombreuses Significations de la Disjonction Simple, Négative et Modale : Aperçus du Français L1

Mots clés : Disjonction, acquisition L1, implicature scalaire, inférence conjonctive, exhaustification

Résumé : Cette thèse se concentre sur les défis théoriques et développementaux soulevés par la disjonction dans les phrases affirmatives simples, sous la négation et sous les modaux déontiques de possibilité, chez les enfants francophones âgés de 4 à 8 ans.
La première étude de cette thèse compare la performance dans la disjonction simple et la disjonction sous la négation dans la même tâche et au sein des mêmes locuteurs. Nous montrons que l'interprétation de la disjonction, qu'elle soit adulte ou non-adulte, est corrélée à travers les deux contextes. A partir de Singh et al. (2016), nous proposons que la lecture conjonctive des enfants en contexte simple et la lecture *ni…ni…* en contexte négatif peuvent toutes deux être expliquées par une analyse unifiée se basant sur l'approche grammaticale des implicatures scalaires.
En testant les adultes sur la disjonction sous la négation, avec et sans manipulations prosodiques, nos résultats ont révélé deux populations de locuteurs francophones concernant la portée de la disjonction par rapport à la négation, une conclusion valant également pour les enfants. Enfin, cette thèse présente un nouveau paradigme expérimental pour tester la disjonction modale. Nous avons montré que certains enfants produisent une inférence modale conjonctive en lieu et place de l'inférence de libre choix attendue. Pour rendre compte de ce comportement, nous avons proposé que les enfants insèrent localement un opérateur silencieux d'exhaustification au sein de la structure syntaxique. Nous avons ensuite fait l'hypothèse que la dérivation locale des implicatures scalaires est due à une préférence pour résoudre les inférences d'ignorances le plus tôt possible.

Title: Acquiring the Many Meanings of Simple, Negated and Modal Disjunction: Insight from L1 French

Keywords: Disjunction, L1 acquisition, scalar implicature, conjunctive inference, exhaustification

Abstract: This thesis addresses theoretical and developmental challenges raised by disjunction in simple affirmative sentences, under negation and under deontic possibility modals, in French-speaking children of age 4 to 8.
The first study of this thesis compares the performance in simple disjunctive statements with their negated counterpart within the same individuals and the same task. We show that the interpretation of disjunction, be it an adult-like reading or a non-adult-like one, is related across the two contexts. We build on Singh et al. (2016) to propose that children's conjunctive reading in simple contexts and *neither…nor* reading in negated contexts can be both accounted with a unified analysis based on the grammatical approach to scalar implicatures.
By testing adults on negated disjunction with and without prosodic manipulations, our results revealed two populations of French speakers concerning the scope of disjunction with respect to negation, a conclusion which also holds for children. Finally, this thesis presents a novel experimental paradigm to examine modal disjunction. We showed that some children gave a modal conjunctive interpretation of the expected free choice reading. To account for behaviour, we proposed that some children insert a covert exhaustification operator locally into the syntactic structure. We further hypothesised that the local derivation of scalar implicatures is due to a preference to resolve ignorance inferences as early as possible.