

Asymmetries in Presupposition Projection: Processing and Acquisition

by

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Abstract

In this dissertation, I aim to provide novel evidence to shed light on the projection problem of presuppositions. The focus is on identifying the underlying patterns of how presuppositions project out of two binary connectives, *if* and *or*, by disentangling semantic presuppositions from additional processes. A series of behavioral experiments examine how English-speaking adults process presuppositional sentences in real time, and what children in the preschool age range know about presupposition projection in these constructions, finding a host of evidence in favor of a family of theories that take an asymmetric view of presupposition projection.

The dissertation is organized into three main parts. The first part focuses on the processing of presupposition projection in adults. The real-time processing of presupposition projection out of binary connectives shows an asymmetric pattern, as reflected by response time latencies associated with the left argument compared to the right argument. The second part investigates preschool-aged children's knowledge of presupposition projection out of *if*-conditionals and disjunctions. Results reveal that at the age of 5, children's behaviors reveal an environment-based asymmetry, much like what we observed in adults' processing signature: when the embedded presupposition from the antecedent environment is not globally satisfied, it received much lower endorsement rates, compared to the consequent environment. 6-year-olds have an even more sophisticated command of presupposition projection out of *if*-conditionals, in that they can also recruit presupposition-cancelling mechanisms so as to avoid presupposition failure in a nearly adult-like manner. The third part of the dissertation is on presupposition strengthening. The experimental results in the previous two chapters suggest that there is substantial evidence pointing toward the asymmetric view of presupposition projection across two binary connectives. But the asymmetric view crucially predicts a conditionalized presupposition for the right argument, which is sometimes too weak. I defend the notion of pragmatic strengthening by addressing a challenge posed by Mandelkern (2016a, 2016b), where the classic notions of pragmatic strengthening do not appear to be applicable, yet a stronger, non-conditional presupposition arises contrary to the asymmetric view's predictions.

Building on crucial insights from Fox (2019), I present an idea arguing that this non-conditional presupposition does not in fact directly come from presupposition projection out of the conditional assertion, but is the presupposition of an accommodated question that is salient in the context. The question-based explanation can supplement the asymmetric theories, thereby removing the motivation to opt for an alternative theory that treats the non-conditional presupposition *p* as the basic one.

Ultimately, I defend an asymmetric view of presupposition projection, as advocated by Satisfaction Theory and Trivalent Logics. The experimental findings provide novel empirical support that corroborates the predictions of these theories: for presuppositions projected out of binary connectives, the basic, semantic pattern of projection is asymmetric in nature, with a stronger presupposition projected from the left argument than the right argument. These findings together with a better understanding of the general pragmatic principles that affect discourse structure, provide further empirical and theoretical challenges that will need to be addressed by opposing theories.

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When I was a freshman in college, I took an introduction to linguistics course, and when it ended, I told my academic advisor back then that I wanted to do a PhD in linguistics. “How can you be so sure?” they asked, “You are only a freshman.” I didn’t know how, but I was sure. In retrospect, that was a bit of a crazy thing to say. But the 18-year-old me thought, wouldn’t it be great if I could study linguistics at MIT? And so it happened. That was one of the few things that went exactly as planned in my life.

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Chapter 1

Introduction

1.1 Overview and goals

Natural language makes a distinction between *asserted content* and *presupposition*: while asserted content conveys the main content of the sentence, presupposition conveys information that is being taken for granted. One influential approach to characterizing the status of presuppositions as information being taken for granted is the Stalnakerian view (1974), which proposed that presuppositions impose admittance conditions on the *common ground*. In other words, in order for a sentence to be felicitously uttered in a context, the presupposition of that sentence needs to be shared mutual belief among all discourse participants in the context.

How do we identify that a piece of information is being taken as part of the common ground, i.e., it is expressed as a presupposition? A hallmark property of presuppositions that distinguishes them from asserted content is the way they *project* — in other words, get inherited — from the scope of truth-functional operators. Take negation as an example, a classic entailment-canceling operator that takes a truth value and returns the opposite truth value. As shown below, the asserted component of the sentence in (1) is affected by the introduction of negation in (2), but the presupposed content survives, because the two examples impose the same

admittance condition on the common ground, that Phil has a guitar:

- (1) Phil's guitar is broken.

Presupposition: There is a guitar that Phil owns.

Asserted content: That guitar is broken.

- (2) Phil's guitar is not broken.

Presupposition: There is a guitar that Phil owns.

Asserted content: That guitar is not broken.

A long-standing research agenda in formal semantics and the philosophy of language has been to identify an “algorithm” of presupposition projection — one that can derive the presuppositions of a complex sentence containing one or more logical operators in a compositionally transparent manner. This dissertation contributes to this research agenda.

One early hypothesis about presupposition projection, known as the “cumulative hypothesis” (Langendoen & Savin 1971), says that a complex sentence simply inherits all presuppositions of its parts. But such a hypothesis makes the wrong prediction once we look beyond negation and into environments involving binary connectives, where the empirical facts are more complex (for overviews, see Beaver 2001, Kadmon 2001, Beaver & Geurts 2014, Schwarz 2019). Noted since as early as Karttunen (1973), binary connectives such as *if*-conditionals,¹ conjunctions, and disjunctions are environment where *non-uniform* projection patterns may be found. Take *if*-conditionals as an example, the presupposition projected from the left argument of the connective (3-a) is sometimes stronger than the one projected from the right argument (3-b):

¹I will be calling *if* a binary connective for convenience, but see Chapter 2 Section 2.1.2 for a more detailed discussion of the meaning of *if*-conditionals that I adopt.

- (3) a. If Phil's guitar is broken, he is a real musician.

Presupposes: Phil has a guitar.

- b. If Phil is a musician, he will bring his guitar to the party.

Presupposes: If Phil is a musician, he has a guitar.

While a presupposition triggered in the antecedent of a conditional is fully inherited, a presupposition triggered in the consequent is inherited in a weaker, conditionalized form. Thus, *if*-conditionals seem to be an environment where the nature of the projected presupposition is contingent on the position of the trigger. The general pattern — non-conditional presuppositions projecting from the left argument and conditionalized ones projecting from the right — extends to other binary connectives, like disjunction and conjunction.

A family of theories were developed to capture precisely this generalization about non-uniform presupposition projection in binary connectives. I will be referring to such theories collectively as the *asymmetric* theories of presupposition projection, for expository convenience. The asymmetric theories have played a prominent role in the study of presupposition. However, all of them face a challenge commonly referred to as “the proviso problem” (Geurts 1996). There are cases like (4) where the presupposition projected from the right argument of binary connectives appears to be non-conditional, which is stronger than what the asymmetric theories predict. The existence of such data calls into question the empirical validity of the asymmetric theories.

- (4) If Phil is traveling to London, he will bring his guitar on the trip.

Presupposes: Phil has a guitar.

In this dissertation, I aim to provide novel evidence that further supports the asymmetric theories of presupposition projection. Focusing on two binary connec-

tives, *if* and *or*, this dissertation presents a series of behavioral experiments with adults and children that aim at disentangling the semantic presuppositions projected from these environments from additional pragmatic mechanisms that might result in weaker or stronger “felt” presuppositions. Results from these studies suggest that presuppositions indeed project non-uniformly from these environments; in particular, the presupposition projected from the right argument of binary connectives is a conditionalized one.

In what follows, I introduce two prominent asymmetric theories of presupposition projection. Then, I discuss the proviso problem and how it challenges the whole family of asymmetric theories.

1.2 Asymmetric theories of presupposition projection

What I have been referring to as the asymmetric view of projection takes Karttunen’s generalization as the starting point: from the right argument of binary connectives, only a weak, conditionalized presupposition projects. But the asymmetric theories are not a monolith. There are two prominent asymmetric theories, Satisfaction Theory and Trivalent Logics, which share little in common *vis-a-vis* their conceptualization or their formal system, yet both fall under my characterization of the asymmetric view. For this reason, I will provide a brief review of both theories and show how they derive non-uniform projection in binary connectives.

1.2.1 Projection in Satisfaction Theory

Satisfaction Theory (Stalnaker 1973, 1974; Karttunen 1974; Heim 1983, 1990, 1992; Beaver 2001; von Fintel 2008; Rothschild 2011; a.o.), often couched within dynamic semantics, essentially semanticizes the Stalnakarian intuition that presuppositions

are admittance conditions on the common ground. The system in Heim (1983) for example, treats meanings as instructions to update the common ground, i.e., what is called “context change potentials” (CCP). The CCP of a binary connective is specified in such a way that not only does it encode truth conditional information, but it also produces the presupposition projection properties of each connective in the system as their “definedness conditions”. Satisfaction Theory requires that presuppositions be satisfied *locally*:

- (5) ***Local Satisfaction***: p presupposes everything that is required to ensure that all of p 's constituents have their presuppositions locally entailed in any c .

Karttunen (1974) provides a definition for the local contexts of evaluation for a range of linguistic environments, and suggests that presuppositions always need to be satisfied in the local context in which the presupposition trigger is evaluated. From this, it follows that the presuppositions of a complex sentence will be whatever propositions must be in c in order to ensure that the presuppositional requirements are satisfied in the local context.

Local Satisfaction correctly predicts the following contrast:

- (6) a. If Sam's sister is flying to visit him, he will pick her up at the airport.

Presupposes: Sam has a sister.

- b. If Sam has a sister, he'll pick up his sister at the airport.

Presuppositionless

In (6-a), the conditional as a whole presupposes that “Sam has a sister”, which is correctly predicted by *Local Satisfaction*: its antecedent clause is the initial instruction to update the context, and that is also where the presupposition trigger is found. An utterance of (6-a) can only be felicitous in a context where Sam actually has a sister — the embedded presupposition projects fully in this case. By contrast, the same

embedded presupposition does *not* project to become the presupposition of the entire conditional in (6-b), because it's already locally entailed by the new local context to which the left argument of *if* has been updated — a prediction that *Local Satisfaction* correctly makes.

How does Satisfaction Theory derive a conditionalized presupposition from the right argument of binary connectives? In (7), only a conditionalized presupposition is projected from the consequent of the *if*-conditional:

- (7) If Phil is a musician, he will bring his guitar to the party.

Presupposes: If Phil is a musician, he has a guitar.

In this case, the embedded presupposition “Phil has a guitar” is evaluated against a local context in which “Phil is a musician” has been updated to the context. The presuppositional requirement of the sentence states that the update of (7) results in undefinedness iff (i) the update of the antecedent to the local context is undefined, or (ii) the update of the consequent to the new local context updated by the antecedent is undefined. From this, it follows that the felicity condition that (7) poses to the common ground is that “If Phil is a musician, he has a guitar”.

1.2.2 Projection in Trivalent Logics

Unlike Satisfaction Theory, Trivalent Logics begin with the assumption that the logical system utilized by natural language cannot be a traditional, two-valued logic. Despite sufficient knowledge of the relevant facts, one cannot clearly judge some sentences as either true or false. Presuppositional sentences, such as “Phil’s guitar is not broken”, fall within this category when evaluated in a situation where Phil doesn’t actually have a guitar. One might describe the sentence as “neither true nor false”. Cases like these have led researchers to the conclusion that minimally, a three-valued (represented by #) or trivalent logic is required.

Thus, a family of theories approach the problem of presupposition projection by making use of trivalent logics (Kleene 1952; van Fraassen 1969; Peters 1979; Kracht 1994; Beaver & Krahmer 2001; George 2008; Fox 2008, 2013). In terms of projection, when an atomic sentence is embedded under a logical operator, the system algorithmically derives when the third value $\#$ is inherited by the complex sentence, and when it is not. Under this view, presupposition projection can thus be characterized as ‘third-value inheritance’.

One way of conceptualizing $\#$ is to take it to represent *uncertainty*, i.e., the value that is assigned when there is simply insufficient information to determine truth or falsity. This view is what underlies the Middle Kleene logic (Peters 1979; Kracht 1994; Beaver & Krahmer 2001; George 2008, 2014) and the Strong Kleene logic (Fox 2008, 2013; Mayr & Romoli 2016). Under the Middle Kleene logic, for a binary connective like *if*, the entire conditional receives the third value $\#$ when (i) the left argument is $\#$, or (ii) the left argument is true but the right argument receives $\#$.

Table 1.1: Truth table for *if* under the Middle Kleene logic

\rightarrow	1	0	$\#$
1	1	0	$\#$
0	1	1	1
$\#$	$\#$	$\#$	$\#$

When the left argument of *if* carries a presupposition trigger (*if* ϕ_p , ψ), the sentence can avoid receiving $\#$ only in a context where p is 1; it follows that the presupposition projected from this environment is a non-conditional one, p . By contrast, when the right argument of *if* carries a presupposition (*if* ϕ , ψ_p), according to the truth table in Table 1.1, the sentence can only avoid being assigned $\#$ in a context where *if* ϕ , p ; from there, it follows that the presupposition projected from there is a conditionalized one. This way, the Middle Kleene derives an asymmetric pattern of project for conditionals, with the semantic presupposition of the consequent taking a conditionalized form.

Note that the Strong Kleene logic also takes the weaker, conditionalized presupposition as the more ‘basic’ one being projected from the right argument of both *if* and *or*. It produces an asymmetric pattern for *if* (Table 1.2a), just like the Middle Kleene logic. However, by itself, it makes a different prediction for disjunction (Table 1.2b):

Table 1.2: Truth tables under the Strong Kleene logic

(a) <i>if</i>				(b) <i>or</i>			
\rightarrow	1	0	#	\vee	1	0	#
1	1	0	#	1	1	1	1
0	1	1	1	0	1	0	#
#	1	#	#	#	1	#	#

On this view, a disjunction is true if at least one of the disjuncts is true, false if both disjuncts are false, and it is assigned # otherwise. In other words, a disjunction can be true *even if* one of the disjuncts is undefined. However, it has been shown by Fox (2008), who builds on Schlenker (2008), that the Strong Kleene logic can also derive the same results as the Middle Kleene logic once we add to it an incremental evaluation component, with which the value of the sentence is determined based on what we’ve encountered at the point of sentence processing at which # is encountered; these results in fact also converge with the predictions of dynamic semantics for both *if* and *or*.

Thus, for our familiar example (8), deriving a conditional presupposition as the semantic presupposition projected from the right argument of *if* is also straightforward:

- (8) If Phil is a musician, he will bring his guitar to the party.

Presupposes: If Phil is a musician, he has a guitar.

The presupposition trigger is embedded in the consequent clause, and as such the whole conditional only requires that “if Phil is a musician, he has a guitar” is true in

the context. It follows from there that the semantic presupposition of (8) as a whole is a conditionalized one.

1.3 The proviso problem and pragmatic strengthening

Though asymmetric theories, like the two outlined above, predict a conditional presupposition from the right arguments of binary connectives, the empirical picture appears more complicated. Consider the pair of sentences in (9): whereas the presupposition of (9-a) is weaker, taking a conditionalized form, the felt presupposition of (9-b) is that *Phil has a guitar*.

- (9) a. If Phil is a musician, he will bring his guitar to the party.

Presupposes: If Phil is a musician, he has a guitar.

- b. If Phil is traveling to London, he will bring his guitar on the trip.

Presupposes: Phil has a guitar.

In (9-a), whether or not presupposition failure obtains depends crucially on the truth of the antecedent. Under Trivalent Logics, for instance, a bivalent value could be assigned in case the antecedent is false — the entire conditional would then be true, irrespective of the value of the consequent. But if the antecedent is true, then the sentence can only avoid presupposition failure if Phil in fact has a guitar. This is in line with the predictions of asymmetric theories. However, the felt presupposition in (9-b) is stronger than what is predicted: here we get a non-conditional presupposition. There is thus a mismatch between what the asymmetric theories predict about presupposition projection out of two-place connectives *versus* what is actually felt to be taken for granted by the speaker of the presuppositional sentence. By themselves,

asymmetric theories systematically predict that a conditionalized presupposition is projected in both (9-a) and (9-b). The problem, as mentioned, is called the “proviso problem”, and it has posed a serious challenge to the entire family of asymmetric theories.

A common response to the proviso problem goes along the following line (Karttunen & Peters 1979, Soames 1982, Heim 1990, 1992, Beaver 1992, 1999, 2001, Heim 2006, van Rooij 2007, Singh 2007, 2008, von Fintel 2008, Pérez Carballo 2008, Fox 2013, Schlenker 2011, Lassiter 2012, Lauer 2015, Sudo 2014; a.o.): the contrast between (9-a) and (9-b) can be explained once we supplement the asymmetric theories with a *pragmatic strengthening* mechanism, which is thought to be regulated by some plausibility-based considerations of the conditional presupposition, or some notion of independence (cf. Mandelkern & Rothschild 2019). The idea is that asymmetric theories are correct in taking the conditional presupposition to be the semantic presupposition in both (9-a) and (9-b). But pragmatic strengthening applies asymmetrically only to (9-b), leading to a stronger, non-conditional presupposition. This is because given our world knowledge, “if Phil is traveling to London, he has a guitar” is a rather strange conditional. It is quite implausible that a speaker intends the listener of this utterance to shift to a common ground that entails only the conditional presupposition, and yet leaves open whether Phil actually has a guitar. Instead, it is more plausible to imagine that the speaker wants the listener to shift to a common ground that simply entails that Phil has a guitar. By drawing on general pragmatic principles, this explanation thus keeps intact the key predictions of asymmetric theories about the semantic presupposition projected out of binary connectives.

The idea of a pragmatic strengthening mechanism seems reasonable enough, and it provides an intuitive solution to the unpredicted strong presuppositions. However, a recent set of data from Mandelkern (2016a, 2016b) seem to suggest that pragmatic strengthening cannot be at the source of all non-conditional “felt” presuppositions.

He provided a series of examples of “unexpected strengthening”, where a stronger, non-conditional presupposition is felt to be projected from the consequent of an *if*-conditional, even though there seems to be no obvious pragmatic reasons for ruling out the conditional presupposition. Mandelkern argues that these data problematize the notion of pragmatic strengthening. And since the strengthening mechanism is an indispensable component of the asymmetric theories, it must be that these theories themselves are *not* sustainable. These data could potentially undermine the empirical success of the asymmetric theories of projection.

1.4 Outline of the dissertation

Though prominent theories of presupposition predict that presuppositions triggered in the right argument of binary connectives project conditionally, in a variety of contexts, this prediction does not seem to be born out. Which set of data — those confirming to the predictions, or those countering the predictions — should be taken as evidence for the underlying semantic presupposition of the sentence? To a large extent, this is an empirical question, and a major goal of this dissertation to try and clarify the empirical picture. To do so, I turn to two novel sources of evidence: online processing and language development. Focusing on *if*-conditionals and disjunctions, I ask whether we can find ways of disentangling the semantic presupposition from additional pragmatic mechanisms (e.g., strengthening, weakening) by (i) looking at implicit measures like response times, and (ii) looking at a pragmatically less savvy population.

In Chapter 2, I focus on the processing of presupposition projection in adults, and ask whether asymmetric expectations about the projected presupposition are reflected in asymmetries in response times. To preview the results, we first find that the real-time processing of presupposition projection out of *if*-conditionals is asymmetric, as

reflected in response time latencies in the antecedent environment compared to the consequent environment in contexts that went against an expected non-conditional presupposition. We then use the same paradigm to test for asymmetry in disjunction, and replicate the asymmetry in this environment. Together, the findings align with the prediction of the asymmetric theories.

In Chapter 3, I investigate children’s knowledge of presupposition projection from *if*-conditionals. Developmental evidence could help clarify the picture as to the underlying semantic presupposition, if this population has less access to pragmatic strengthening and weakening mechanisms. We find an environment-based asymmetry in 5-year-olds, who treat presuppositions triggered in the antecedent of a conditional as projecting non-conditionally, but those triggered in the consequent as projecting conditionally.

Ultimately, I defend the asymmetric view of presupposition projection. The experimental findings provide novel evidence in favor of the predictions of such a view: for semantic presuppositions projected out of binary connectives, the pattern of projection is asymmetric in nature, with a stronger presupposition projected from the left argument than the right argument. These findings, together with a better understanding of the general pragmatic principles that are involved in establishing discourse coherence, provide further support that the asymmetric theories of projection are empirical superior.

Chapter 2

Processing of Presupposition Projection

2.1 Introduction

The asymmetric theories of presupposition projection, which we introduced in Chapter 1, take the core generalizations in Karttunen (1973) as their empirical foundation. But at the same time, there have been discoveries that complicate the empirical picture, leading to long-lasting debates about what the right generalizations really are. To see the problem, recall the key contrast in (10), where identical presupposition triggers are embedded in highly similar consequents. The presuppositions of the two complex sentences seem to differ: whereas the felt presupposition of (10-a) is that Phil has a guitar, the presupposition of (10-b) is weaker, taking a conditionalized form.

- (10) a. If Phil is traveling to London, he will bring his guitar on the trip.

Presupposes: Phil has a guitar.

- b. If Phil is a musician, he will bring his guitar to the party.

Presupposes: If Phil is a musician, he has a guitar.

This contrast can be corroborated by applying the ‘Hey wait a minute’ test (von Fintel 2004). Generally, if a speaker utters a sentence presupposing p , another discourse participant can respond with “Hey wait a minute, I didn’t know that p ” to protest the fact that the speaker has presupposed something that was not mutual belief. By this criteria, we observe that a protest against the non-conditional presupposition — that Phil has a guitar — results in a felicitous continuation in (11-a), but not in (12-a). In contrast, protesting against the weaker presupposition is infelicitous in (11-b), but felicitous in (12-b).

- (11) If Phil is traveling to London, he will bring his guitar on the trip.
 - a. Hey wait a minute — I didn’t know Phil has a guitar?
 - b. ??Hey wait a minute — I didn’t know that people traveling to London have a guitar?

- (12) If Phil is a musician, he will bring his guitar to the party.
 - a. ??Hey wait a minute — I didn’t know Phil has a guitar?
 - b. Hey wait a minute — I didn’t know that musicians have a guitar?

According to the asymmetric theories, the semantic presuppositions projected from both (11) and (12) are actually *underlyingly the same*. (12) is the more “basic” case that reflects the semantic presupposition. However, extra-linguistic factors interfere in the case of (11). Specifically, given that it is unlikely that the speaker of the sentence had in mind a context where Phil’s ownership of a guitar is conditional on his travel plans, the listener accommodates a stronger presupposition which, because it asymmetrically entails the weaker one, would satisfy any felicity requirements imposed by the sentence on the common ground.

But is this the correct way of characterizing the key contrast? An alternative approach, which underlies what I will refer to as the *symmetric* theories of projection

(Gazdar 1979; Geurts 1996; van der Sandt 1992; 1979; Mandelkern 2016a, 2016b, Winter 2019; a.o.), instead takes the non-conditional presupposition in (11) to be more “basic”. For example, in the system adopted in Geurts (1996), a presupposition is bound just like an anaphora, but it cannot be bound in cases where it cannot find a suitable antecedent, e.g., cases where the reference of a definite description has never been introduced into the discourse. As a concrete example, for (11), the presupposition embedded in the consequent, “Phil has a guitar”, can be initially represented as in (13-a). Since in this case, the existential presupposition cannot be bound due to lacking an appropriate antecedent, in the above-mentioned framework, the presupposition itself needs to be inserted in some structure that is “accessible” to it, resulting in (13-b).

- (13) a. $[: [: \text{Phil travels to London}] \Rightarrow [z: z \text{ is Phil's guitar}, \text{Phil will bring } z]]$
- b. $[z: z \text{ is Phil's guitar}, [: \text{Phil travels to London}] \Rightarrow [: \text{Phil will brings } z]]$

The structure in (13-b) entails that Phil has a guitar, and thus this is the semantic presupposition predicted by the theory, which in this case is indeed the felt presupposition in (11).

By contrast, on the same view, the conditionalized presupposition felt in cases like (12) is derived via a weakening process of *local accommodation*. Local accommodation essentially cancels or suspends the presupposition when embedded under logical operators (Heim 1983), and generates a re-interpretation that accounts for the intuition we have for (12), i.e., there is no commitment to the proposition “Phil has a guitar”.

Both types of approaches can account for the core data once they supplement the projection mechanism with some relevant additional processes. For asymmetric theories, the semantic presupposition is the conditional presupposition as in (12), and a strengthening mechanism helps to account for cases like (11); for symmetric theories,

the basic case is (11), and a weakening process is used to explain (12). The existence of these additional mechanisms can make the task of identifying the basic semantic presupposition non-trivial. Our intuitions about what the speaker of a sentence S presupposes are not reliable enough indicators of what the semantic presupposition of S is, as strengthening and weakening mechanisms can lead to mismatches between what the compositional machinery outputs and what we infer the speaker to be taking for granted.

In this chapter, I turn to a different sort of measure to address this challenge: the online processing signature of presuppositional sentences. If indeed our intuitions about what a sentence presupposes is the outcome of compositional semantics plus any additional pragmatic processes, then the task of figuring out what the semantics contributes is intimately linked to pinpointing where additional processes apply. Looking at online processing can help in this task, as it can provide a “magnifying glass” through which we can detect otherwise nuanced differences. In this specific case, we may be able to identify the deployment of additional processes through differences in how people respond to sentences that trigger them *vs.* not.

Previous experimental work has looked at processing evidence to probe whether particular interpretations of presuppositional sentences require additional mechanisms, in particular the recruitment of local accommodation (Chemla & Bott 2013; Romoli & Schwarz 2015; Zehr & Schwarz 2016). A consistent finding is that the recruitment of local accommodation during real-time comprehension — which often results in a “presupposition-less” reading — incurs a processing cost, often measured by response times. In Chemla & Bott’s (2013) experiment, for instance, participants were tasked with evaluating whether a sentence like (14) is true. (14), crucially, involved a negated factive verb (*realize*) embedding a proposition that common knowledge tells us is false (e.g., that elephants are birds), and the resulting meaning, (14-a), is something that might be judged as false. If the presupposition is locally accom-

modated, however, the reading is akin to that in (14-b), which can be judged true. Crucially, responding “true” in these cases took significantly longer than responding “false”, which was taken to implicate that additional processes were involved in accessing the interpretation in (14-b) compared to (14-a).

- (14) Zoologists do not realize that elephants are birds.

 - a. [Elephants are birds] and NOT [zoologists believe so] (false)
 - b. NOT [(Elephants are birds) AND (zoologists believe so)] (true)

In our study, we extend the logic of these studies to projection from binary connectives by examining what circumstances — both linguistic and contextual — trigger the application of local accommodation. This is useful in our case because different theories of projection predict different patterns of the application of local accommodation. To illustrate, consider the minimally contrasting pair in (15):

- (15) a. If Phil's scarf is striped, he wears a yellow hat.
b. If Phil wears a yellow hat, his scarf is striped.

In both cases, it is in principle possible to access a reading of the sentence where the speaker is not committed to Phil's having a scarf. In the case of (15-a), this reading requires local accommodation on either the asymmetric or the symmetric approach — both of them predict that the embedded presupposition projects wholesale in this environment. The symmetric theories predict that local accommodation is also necessary in the case of (15), since the basic semantic presupposition there is also “Phil has a scarf”. However, on the asymmetric theories, the semantic presupposition of the sentence is a weak, conditionalized one, which does not commit the speaker to the proposition “Phil has a scarf” and thus need not invoke local accommodation (summarized in Table 2.1).

Table 2.1: Predictions about semantic presuppositions under the two views

	Asymmetric view	Symmetric view
$If \phi_p, \psi$	p	p
$If \phi, \psi_p$	$if A, p$	p

The distinct predictions made by these approaches with respect to when local accommodation is necessary could translate to distinct processing signatures, if prior work is correct that the application of local accommodation incurs a processing cost.

The rest of this chapter is organized as follows. Section 2 reports two experiments that investigated the processing of presuppositional conditionals. The investigation is then extended to disjunctions, which is motivated in Section 3 and reported in Section 4. Finally, Section 5 summarizes the findings and discusses the implications of the present work.

2.2 Processing presupposition in *if*-conditionals

2.2.1 Experiment 1

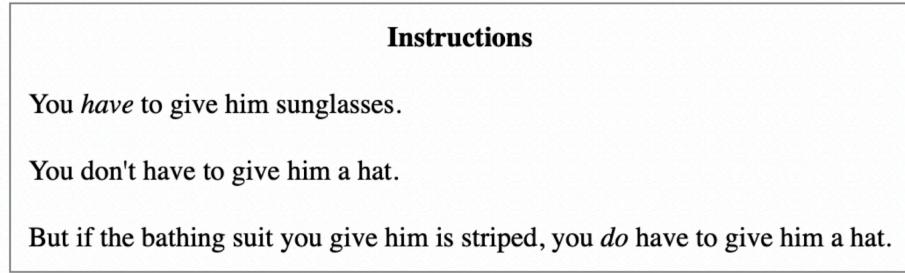
We investigate the processing of presuppositional *if*-conditionals in adults, varying whether the presupposition is triggered in the antecedent or the consequent.

2.2.1.1 Overview of the paradigm

We use a novel Outcome Evaluation Task to probe participants' understanding of presuppositional sentences. The general setup of such a task is as a kind of dress-up game. An (unseen) character first gives a set of instructions on how another character (a stick figure) should be dressed up (Figure 2-1).

The set of instructions was always presented in 3 lines, regardless of the experimental condition. The first line takes the form of “You have to give him *Object*₁”, where *Object*₁ always appeared in the dress-up. The second line takes the form of

Figure 2-1: Workflow in Experiment 1 with a sample first scene



“You don’t have to give him *Object₂*”, where *Object₂* may or may not appear depending on the experimental condition. The third line, which is the critical portion of the instructions, involves a conditional statement which carries an existential presupposition (e.g., there is a bathing suit). *Object₂* from the second line of the instruction appears in this conditional statement, either in the antecedent (“If you do give him *Object₂*...”) or the consequent (“... you do have to give him *Object₂*”), in order to ensure the naturalness of the conditional statement.

After 3 seconds of showing the instruction, a button would appear below which participants could click on to advance to the next page, although they were allowed to inspect the instructions for as long as they wanted.¹ On the second page, an outcome image showing how someone has dressed the stick figure was presented, with the instructions repeated above the image but in gray and a smaller font size, serving as a reminder (Figure 2-2). On the same page, participants were asked to decide whether the dress-up was in accordance with the instructions, by pressing the Yes or No button. Participants had **6 seconds** to make the decision, before the image disappeared.

Thus, in this experimental paradigm, the participants are tasked with assessment of instruction adherence, rather than directly providing their truth value judgements of presuppositional sentences. It is worth noting that the link between our main mea-

¹Text selection was disabled on the webpage, so participants would not be able to copy and paste the instructions to a local text editor.

Figure 2-2: Workflow in Experiment 1 with a sample second scene

Instructions

You *have* to give him sunglasses.

You don't have to give him a hat.

But if the bathing suit you give him is striped, you *do* have to give him a hat.

This is how someone dressed the stickman.



Did they do an OK job following instructions?

sure and the participants' interpretations of the instruction sentences is an indirect one. To be more specific, the participants first read a presuppositional conditional, "uttered" by an instruction-giver (the speaker) to the instruction-receiver (the listener). Assuming that the speaker is cooperative, it is reasonable to take any presuppositions of the sentences to be common ground (e.g., "there is a bathing suit that you give him"). The subsequent image reveals the outcome of the dress-up, which may show that the listener did not act in a manner that took the presupposed content into consideration (e.g., the stick figure did not wear a bathing suit).

At this point, the participants have two choices: (i) assume that the instruction-receiver did not actually adhere to instructions, by not putting on an article of clothing that was previously taken for granted that they would (resulting in a “No” response); (ii) assume that the instructions were adhered to, but the participant’s own initial interpretation of the instruction-giver’s utterance was wrong, triggering a revision (resulting in a “Yes” response). This revision process is the process of presupposition cancellation, which re-generates an interpretation of the instruction sentences along the lines of “if there is a bathing suit you give him and it is striped, you have to put on a hat.” In connection to the literature of processing presuppositions, we will describe this process as local accommodation by default, but note that ultimately, it is not necessary for us to subscribe to this particular mechanism.

2.2.1.2 Design and materials

There were three target conditions which form our key comparison, each with 12 trials, with an example shown in Table 2.2:

- **p_true**: requirements from the embedded presupposition (e.g., that there is a scarf given) are obeyed in the dress-up; requirements from the antecedent and the consequent clauses are both obeyed as well. Participants are expected to arrive at a “Yes” response.
- **p_critical**: requirements from the embedded presupposition are not obeyed in the dress-up. Neither clothing mentioned in the conditional sentence appears on the stick figure in the outcome.
- **control**: A non-presuppositional control condition with identical outcomes as p_critical, where the conditional statements always have a false antecedent, but there is no presupposition trigger involved. Participants are expected to arrive at a “Yes” response.

The environment where the presupposition-trigger appeared (Antecedent vs. Con-

Table 2.2: Sample materials for Experiment 1

Condition	Outcome Image	Environment (Trigger Position)	
		Antecedent	Consequent
Consistent across conditions		You <i>have</i> to give him a hat. You don't <i>have</i> to give him gloves...	
p_true		But if <u>the scarf you give him</u> is striped, you do have to give him gloves.	But if you do give him gloves, <u>the scarf you give him</u> has to be striped.
p_critical		But if <u>the scarf you give him</u> is striped, you do have to give him gloves.	But if you do give him gloves, <u>the scarf you give him</u> has to be striped.
control		But if you give him a striped scarf, you do have to give him gloves.	But if you do give him gloves, you have to give him a striped scarf.

sequent) was a between-subject factor. For the target conditions described above, both the p_true and the control conditions have “Yes” as the expected response; for p_critical, the instructions can be evaluated as being followed with the additional process of local accommodation. For the purpose of comparison, we will also focus on the “Yes” responses for the p_critical condition in the response time analysis.

The purpose of the control trials is to address the following concern: we ask whether the times taken to arrive at a “Yes” response in p_critical vary when the trigger is in the antecedent environment *versus* when it is the consequent environment. However, since there is a false antecedent in this condition, participants might adopt a strategy of recalling and interpreting the conditional sentences in a piece-meal fashion, such that once they have determined the antecedent of the conditional to be false, the consequent will be entirely skipped. Should this be the case, any

asymmetry we find in the expected direction cannot be taken as evidence in favor of the asymmetric application of local accommodation, since it could be that the presupposition trigger in the consequent clause is not processed at all. By having the presupposition-less control items, we establish a baseline for processing a conditional with a false antecedent but no presuppositions, which will be important for interpreting the results. In our between-subject design, identical control items will be used in the Antecedent study and the Consequent study, and we should expect to see no difference in the response times for these control trials across environments.

In addition, we also included two types of fillers that have “No” as the expected response. All of the filler items served to mask the purpose of the experiment and were also used to check if the participants are paying attention:

- **p_false** (12 trials): requirements from the embedded presupposition are obeyed in the dress-up; requirements from the antecedent clause of the conditional are obeyed, but not the consequent clause. Participants are expected to respond No.
- **False non-presuppositional filler** (24 trials): all of these 24 fillers also take the form of a conditional statement, and have an outcome image that involves only one clothing item on the stick figure. This is to counterbalance the expected responses of all trials with one-object images, and control for the possibility of participants adopting an image-based strategy when answering p_critical and control conditions, both of which also have only one clothing item in the outcome images.

The experiment began with 4 practice trials, for which feedback was provided to the participants. Afterwards, the order of all items is randomized. For control trials and fillers, feedback was provided to the participants half of the time.

Table 2.3: Sample filler items for Experiment 1

Condition		Outcome Image	Sentence
p_false	Antecedent		<p>You have to give him an umbrella. You don't have to give him a pipe.</p> <p>But if the briefcase you give is black, you do have to give him a pipe.</p>
	Consequent		<p>You have to give him an umbrella. You don't have to give him a pipe.</p> <p>But if you do give him a pipe, the briefcase you give him has to be black.</p>
Non-presuppositional filler (false)			<p>You don't have to give him an umbrella. You don't have to give him a pipe.</p> <p>But if you do give him a pipe, you have to give him an umbrella.</p>

2.2.1.3 A note on our linguistic materials

As described in the previous section, our critical sentences take the following forms, and readers may notice that these presuppositional conditionals involve a deontic modal, *have to*:

- (16) a. If the scarf you put on is striped, you *have to* put on a coat.
- b. If you put on a coat, the scarf you put on *has to* be striped.

How might this impact the presupposition that is projected out of these conditionals? Below, I will spell out my assumptions of the meaning of these conditional sentences, roughly following von Fintel & Heim (1997–2021), and discuss their interpretations in the context of our experimental paradigm.

In the task, the presuppositional conditionals are presented as pieces of instructions, which are expected to be followed in the dress-up of the main character. The deontic modal *have to* in these sentences is being used *performatively*, meaning that it serves to create a norm, rather than describes an existing one. I take the performa-

tive use of the deontic modal *have to* in these presuppositional conditionals to restrict the range of normatively acceptable options available to an agent (i.e., the addressee of the sentences, in this case whoever is dressing up the stick figure), in line with a Kratzerian view of the meaning of conditionals (Kratzer 1986). The meaning of *have to* is defined as below:

$$(17) \quad [\![\text{have to}]\!]^w = \lambda p_{\langle s,t \rangle} : \forall w' . \text{The instruction in } w \text{ is being followed in } w' \\ \rightarrow p(w') = 1$$

The conditional sentences in (16) have the following structures:

- $$(18) \quad \begin{array}{l} \text{a. if } \phi_p, \text{ have to } \psi \\ \text{b. if } \phi, \text{ have to } \psi_p \end{array}$$

I do not take such structures to involve two layered operators, i.e., a conditional construction embedding or embedded inside a modal construction. Rather, I take the *if*-clause as not supplying its own operator meaning but serving as a restriction on the modal base of the modal operator (Kratzer 1986). Such structures essentially say that, among those worlds where the proposition ϕ holds, the ones favored by the instruction as it is in the actual world are all worlds where ψ . That will be the meaning of our conditional sentences involving *have to*.

With these assumptions in place, for the structure in (18-a) which corresponds to our Antecedent condition in (16-a), the sentence says that “among those worlds where the scarf you put on is striped, the ones favored by the instruction are all worlds where you put on a coat.”

$$(19) \quad [\![(\text{16-a})]\!]^w = 1 \text{ iff } \forall w' \in \text{NORM}(w) : \text{Striped}(\iota x[\text{scarf.you-wear}(x,w)], w') \\ \rightarrow \text{you-wear-coat}(w')$$

The caveat concerning the interpretation of the sentence, which impacts the inter-

pretation of the presupposition, is which world is the definite description being evaluated in; in other words, is x evaluated in w or w' ? It is important at this point to consider the experimental setup, against which these sentences are being evaluated. Importantly, in the critical conditions in which these presuppositional conditionals are presented as instructions, the outcome scene is such that the presupposed item is not present (e.g. no scarf). As such, an interpretation with of x in the actual world w is simply not viable; if we apply local accommodation, it will just be trivially true in that case. Thus, the only option that remains is x is being evaluated in w' , the worlds favored by the instruction. Under this interpretation, the presupposition projected out of the conditional is p .

For thoroughness, let's also look at the structure in (18-b) which corresponds to our Consequent condition in (16-b). This time, the sentence says that “among those worlds where you put on a coat, the ones favored by the instruction are all worlds where the scarf you put on is striped.”

$$(20) \quad \llbracket (16\text{-}b) \rrbracket^w = 1 \text{ iff } \forall w' \in \text{NORM}(w) : \text{you-wear-coat}(w') \\ \rightarrow \text{Striped}(\iota x[\text{scarf.you-wear}(x,w)], w')$$

Again, how is the definite description being evaluated here? Given the outcome scene of the critical condition, there is no scarf in the actual world, so it cannot be that x is being evaluated in w . The only plausible interpretation that makes sense in our experimental setup is still evaluating x in w' , where the world variable is bound. And assuming universal projection out of the deontic modal, we obtain the conditional presupposition, “if you put on a coat, there is a scarf you put on”.

Thus, taking the experimental setup into consideration, I will be assuming these interpretations for the presuppositional conditionals in our task.

Readers may also notice that since we endorse the Kratzerian analysis of conditionals, it is not appropriate to call *if* a “binary” connective. The literature on

presupposition projection has conventionally been referring to *if*, together with *and* and *or*, as a binary connective, in part because it has not really engaged with the Kratzerian view on conditionals. I will (unfortunately) adopt the convention of referring to *if* as one of the “binary connectives”, partly due to the convenience of being able to collectively refer to *if* and *or* in my studies, but I would like to acknowledge that this way of describing *if* is a somewhat simplistic view and inconsistent with the Kratzerian definition of it.²

2.2.1.4 Data collection

All data collection was virtual and restricted to participants in the U.S. Sample sizes for all experiments were established based on pilot testing and power analyses (**simr** package in R; Green & MacLeod 2016). For Experiment 1, 120 adult participants were recruited via Prolific. The task took approximately 30 minutes, and the participants received monetary compensation for their participation.

We excluded participants who did not pass attention checks (i.e. <70% accuracy in all false items, including the 24 filler items and 12 p_false trials), as well as participants who show an image-based strategy, responding “Yes” whenever the stick figure wears only one clothing item on the outcome image (e.g. the 24 filler items, for which a “No” response is expected).

2.2.1.5 Results and analyses

Performance on p_false and non-presuppositional filler items was at-ceiling, indicating that participants paid attention. These items have “No” as the expected response, and their No-response rates are summarized in Table 2.4:

For the three target trial types, their Yes-response rates are all at-ceiling, as summarized below in Table 2.5 and plotted in Figure 2-3:

²I am in debt to Kai von Fintel for pointing this out to me.

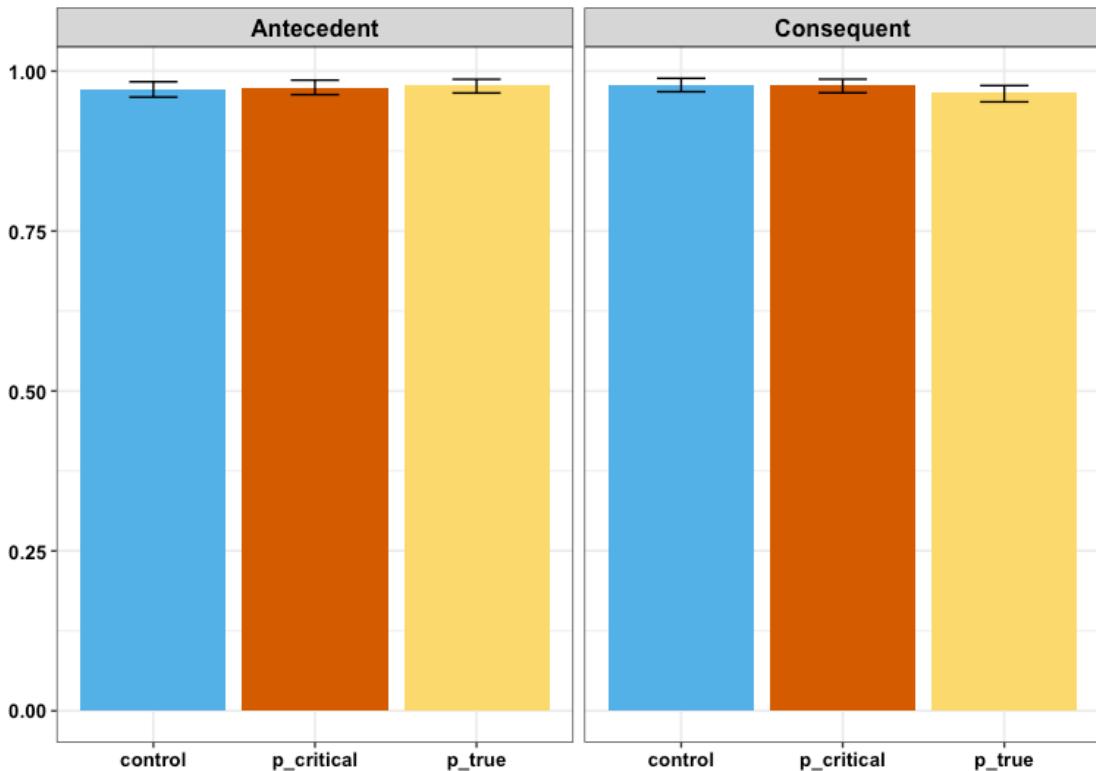
Table 2.4: Rates of responding “No” for filler items from Experiment 1

	Antecedent	Consequent
p_false	96.30%	93.70%
non-presuppositional fillers	99.09%	97.32%

Table 2.5: Rates of responding “Yes” for target items from Experiment 1

	Antecedent	Consequent
p_true	97.72%	96.61%
p_critical	97.45%	97.74%
control	97.20%	97.90%

Figure 2-3: Yes-response rates in the three target conditions in Experiment 1 (N=120)



Notably, the p_critical condition reached high Yes-response rates in both Antecedent and Consequent environments. The high Yes-response rates in Antecedent suggest that participants in the task were charitable in treating as instruction-adherent an outcome in which the presupposed item (e.g., the scarf) was not given. On the asymmetric view, arriving at these Yes responses for the Antecedent environment requires accessing a local accommodation reading of the presuppositional conditional,

as such sentences are otherwise predicted to project a non-conditional presupposition (e.g., that there is a scarf given). But the outcome suggests that the listener did not act in a way that took this for granted. Participants' treatment of the dress-up as instruction-adherent nevertheless suggests that they accessed (perhaps via a revision of their initial interpretation) a presupposition-less interpretation. For the Consequent environment, this issue does not arise. The participants' treatment of the dress-up *is* instruction-adherent, if what was common ground is something weaker, e.g., that a scarf is given *if* gloves are also given.

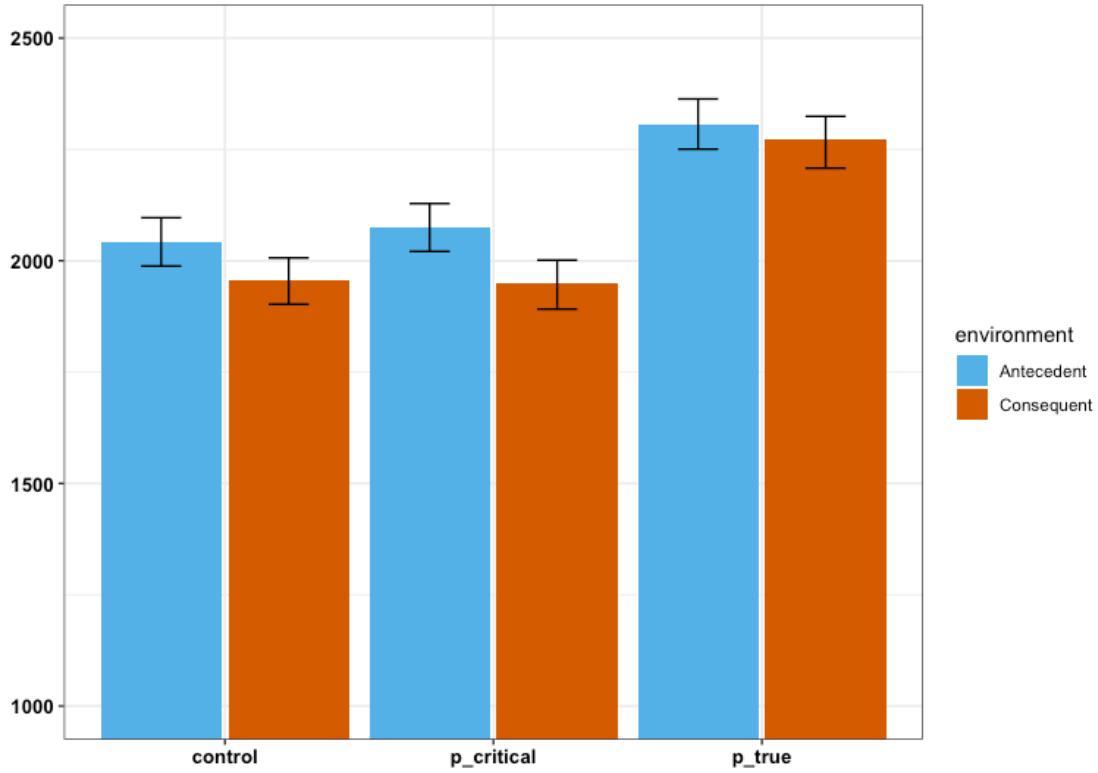
Given our key assumption that accessing the presupposition-less reading (presumably via local accommodation) is costly, we ask whether the time it takes for participants to say “Yes” to the p_critical trials differs significantly across Environments, as the asymmetric view predicts. Results (see Table 2.6 and Figure 2-4) lend tentative support. In p_critical, response times in the Antecedent were 124.91 ms longer than the Consequent. This difference is only 11.65 ms in the p_true condition, where the presupposed item is always given to the stick figure in the outcome and thus no environment-based difference is expected. However, in the control trials, which are identical across environments, the times taken to arrive at a “Yes” response in Antecedent are 118.45 ms longer than Consequent.

Table 2.6: RTs for Yes responses (ms) from Experiment 1

	Antecedent	Consequent	Ant-Cons Difference
p_true	2527.84	2516.19	11.65
p_critical	2239.91	2115.00	124.91
control	2167.84	2049.39	118.45

We subset the data to include only the three target conditions, p_true, p_critical, and control. The data was fit into a generalized mixed-effect model with a log distribution, with Environment and Condition as fixed effects, and Participants and Items as random effects. We used the `glmer` function from the `lme4` package for R

Figure 2-4: Response time for Yes-responses in Experiment 1 (N=120)



to compute the most maximally specified random-effect model that would converge, following Barr et al (2013). The model revealed a significant interaction between Environment and the contrast between p_true and p_critical ($t = -2.845$, $p < .005$), and a main effect of Condition from the contrast between p_true and p_critical. However, we did not find a parallel interaction when comparing p_critical and control ($t = -0.22$, $p = .826$), due to a substantial difference between environments in the control trials.

Table 2.7: Summary of RT analysis from Experiment 1

	Estimate	Std. Error	<i>t</i>	<i>p</i>
Intercept	7.57	0.05	157.24	<.001
Environment	0.06	0.06	1.06	0.29
p_critical vs. control	-0.01	0.03	-0.35	0.73
p_critical vs. p_true	0.18	0.03	6.47	<.001
Environment * p_critical vs. control	-0.01	0.02	-0.22	0.83
Environment * p_critical vs. p_true	-0.06	0.02	-2.85	<.01

2.2.1.6 Discussion

Experiment 1 found an environment-based difference in the times taken to arrive at a “Yes” response in p_critical. When the presupposed item did not appear in the dress-up, endorsing the outcome nonetheless was associated with higher cost in the Antecedent environment compared to Consequent. No such environment-based difference was found for p_true, a condition where the presupposed item did appear in the dress-up across the board. On first blush, this appears to provide evidence in favor of the asymmetric view, on the assumption that the response time latencies in the Antecedent environment reflects the participants having to access a costlier, local accommodation reading of the instruction sentence.

However, Experiment 1 did not find a significant interaction between Environment and the contrast between p_critical and control. Recall that the control trials are essentially non-presuppositional variants of the p_critical trials: there is a false antecedent involved, and the outcome image contained neither clothing items mentioned in the conditional statement. The lack of this interaction is due to a similar difference between Antecedent and Consequent for the control trials. But since these trials are identical across the two environments, such a difference is unexpected, and suggest that third factors are involved. This may undermine the interpretation in favor of the asymmetric view, because the pattern may receive an alternative explanation. Perhaps participants settled on a “shallow” reading strategy, where the evaluation of outcomes depended *solely* on the items mentioned in the antecedent. As soon as they notice that the item mentioned in the antecedent did not appear in the outcome (i.e., all trials in the p_critical_consequent condition and the control condition), they immediately responded “Yes”, perhaps because they know that a false antecedent results in a logically true conditional (i.e., the rest of this conditional instruction becomes simply “irrelevant” or isn’t “applicable”). (They might re-read the instructions more carefully if the items in the antecedent do appear in the outcome, accounting for the

high accuracy on p_true and control conditions). If so, we might then re-characterize the RT-advantage in those trials as a False Antecedent (FA) advantage. Such an interpretation would mean that the response times for p_critical_consequent cannot be taken to necessarily reflect the processing of the presuppositions involved in those trials, if the participants did not read or process the presuppositional consequents carefully enough in the first place.

We speculate that the between-subject design, where participants repeatedly saw sentences with presupposition triggers always in the same position, might have contributed to the (fast) adaptation of such a response strategy. This must be addressed, in order for us to be able to interpret the environment-based response time difference we observed in p_critical as a matter of local accommodation costs. We therefore propose a revised design to address this concern in Experiment 2.

2.2.2 Experiment 2

2.2.2.1 Design and materials

Experiment 2 used the same materials as Experiment 1, but the materials were presented in a block design, with Environment now as a within-subject design.

The choice of a block design was to obviate the FA-advantage that may have introduced a confound in Experiment 1. In the new design, participants saw a long sequence of trials before encountering a trial with a false antecedent (either p_critical or control, order counterbalanced), with the presupposition trigger varying in the Antecedent environment or the Consequent environment. We also included non-conditional fillers in the form of conjunctive sentences to preclude form-based strategies. Thus, the reduced frequency of seeing an FA-trial and the long interval in-between means that an FA-strategy will less useful, assuming that such a strategy develops over time rather than immediately. We therefore expect the FA-strategy not to be as actively recruited.

Furthermore, the proposed design also allows for a more robust detection of the application of local accommodation. Recent work suggests that in the processing of certain types of presupposition triggers (e.g., factives), frequent access to local accommodation reading primes its application in later trials, even when they are unnecessary for interpretation (Zehr & Schwarz 2016). That is, local accommodation could become a default over the course of an experiment, rather than the last-resort repair mechanism it is thought to be. In our task, participants may choose to assume a default “presupposition-less” reading after having had to access such readings enough times. If participants apply local accommodation across the board by default, the sought-after asymmetry might not be detected. The revised design should also reduce such anticipatory applications of local accommodation.

The same three target trial types from Experiment 1 are included:

- **p_true**: requirements from the embedded presupposition are obeyed in the dress-up; requirements from the antecedent and the consequent clauses are both obeyed as well. Participants are expected to arrive at a “Yes” response.
- **p_critical**: requirements from the embedded presupposition are not obeyed in the dress-up. Neither clothing mentioned in the conditional sentence appears on the stick figure in the outcome. Participants are expected to arrive at a “Yes” response (based on results from Experiment 1).
- **control**: A non-presuppositional control condition with identical outcomes as p_critical, where the conditional statements always have a false antecedent, but no presupposition trigger is involved. Participants are expected to arrive at a “Yes” response.

We also included the following filler items in Experiment 2:

- **false conditional filler**: all of these fillers take the form of a conditional statement, and have an outcome image in which only requirements from the antecedent, but not the consequent, are obeyed in the dress-up. Participants

are expected to respond No.

- **conjunctive filler:** a conjunctive sentence is used for these non-presuppositional fillers, to preclude form-based strategies. Each block contains 2 conjunctive fillers, and they have either “Yes” or “No” as the expected response.

Every block contained 7 trials, beginning with a mix of 6 different types of non-critical trials, and ending with a trial that was either p_critical_antecedent, p_critical_consequent, or control (Table 2.8). The order of non-critical trials within each block was pseudo-randomized. There were 9 blocks, yielding a total of 63 trials. The total number of Yes/No expected responses in the entire study was counterbalanced. We counterbalanced the order of which p_critical trial appears in the initial block by creating 2 versions of the experiment for testing, Antecedent_First and Consequent_First.

Table 2.8: Sample workflow for the block design

	Sequence of 6 trials	Trial with a false antecedent
Block 1	(p_true, false conditional filler, conjunction filler) *2	p_critical: trigger in Antecedent
Block 2	(p_true, false conditional filler, conjunction filler) *2	control: no presupposition triggers
Block 3	(p_true, false conditional filler, conjunction filler) *2	p_critical: trigger in Consequent

The experiment began with 4 practice trials, for which explicit feedback was provided to the participants regardless of whether their response was correct. Participants must answer all training trials correctly in order to proceed. Afterwards, the order of all blocks and trials within a block remained the same for all participants.

2.2.2.2 Data collection

200 participants were recruited on Prolific. The sample size is calculated based on the total number of observations for the critical items. In Experiment 1, there were 120 participants. There were 12 p_critical trials for each participant, totaling 1,440

observations. In Experiment 2, with the block design, there were 6 p_critical trials for each participant, with 200 participants we obtained 1,200 total observations, which brought us close to the number of observations for the critical condition in Experiment 1. The same exclusion criteria as before applied.

If our modifications are successful, we anticipate seeing a more robust asymmetry between Antecedent and Consequent in the p_critical condition in the same direction as Experiment 1, as well as a reliable difference between the p_critical condition and the control condition. Such a result would lend stronger support for the asymmetric view of presupposition projection in conditionals.

2.2.2.3 Results and analyses

Performance on non-presuppositional conditional and conjunctive filler items was all at-ceiling, indicating that participants paid attention. The accuracy rates for these items are summarized in Table 2.9.

Table 2.9: Rates of responding “No” to filler items from Experiment 2

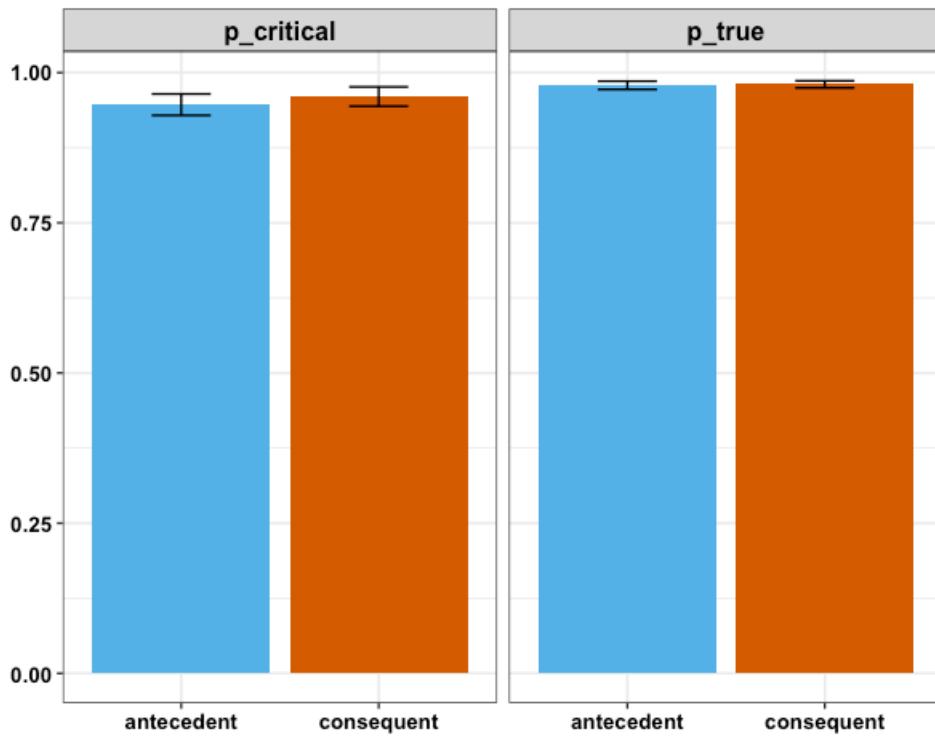
Condition	Accuracy rates
false conditional fillers	95.3%
false conjunctive fillers	99.0%
true conjunctive fillers	99.6%

For the three target trial types, their Yes-response rates are all at-ceiling, similar to what was observed in Experiment 1. These Yes-rates are summarized below in Table 2.10 and plotted in Figure 2-5.

Table 2.10: Results from Experiment 2

	Yes-rates	RTs for Yes responses (ms)
p_true, Antecedent	97.6%	2760.58
p_true, Consequent	98.6%	2758.90
p_critical, Antecedent	94.6%	2713.58
p_critical, Consequent	97.0%	2626.46
control	97.0%	2414.61

Figure 2-5: Rates of responding “Yes” to target items in Experiment 2 (N=200)



We subset the Yes-rates data to include only p_true and p_critical. The data was fit into a mixed-effects logistic regression model, using the same method as in Experiment 1. The model that converged with maximally specified random structure revealed a significant interaction between Environment and Condition ($z = -3.391$, $p < .005$), and a main effect of Condition ($z = 2.568$, $p < .05$). The significant interaction is driving by an environment-based difference in the Yes-rates in the p_critical condition, with the Antecedent environment yielding lower Yes-rates than the Consequent environment, but there is no environment-based difference in the p_true condition.

Table 2.11: Summary of Yes-rates analysis from Experiment 2

	Estimate	Std. Error	z	p
Intercept	4.54	0.48	9.528	<.001
Environment	-0.17	0.63	-0.26	0.79
Condition	3.60	1.40	2.57	0.01
Environment * Condition	-4.92	1.45	-3.39	<.001

For the response time data, we observed that responding “Yes” to the Antecedent

environment takes 87.12 ms longer than the Consequent environment in the p_critical condition, but this difference is only 1.68 ms in the p_true condition. Two sets of analysis were conducted. First, we subset the data to included only p_true and p_critical (plotted in Figure 2-6). The data was fit into a generalized mixed-effect model with a log distribution. The model that converged with maximally specified random structure did not reveal any significant main effects or interaction between Environment and Condition (Table 2.12).

Figure 2-6: Response time for Yes-responses in Experiment 2 (N=200)

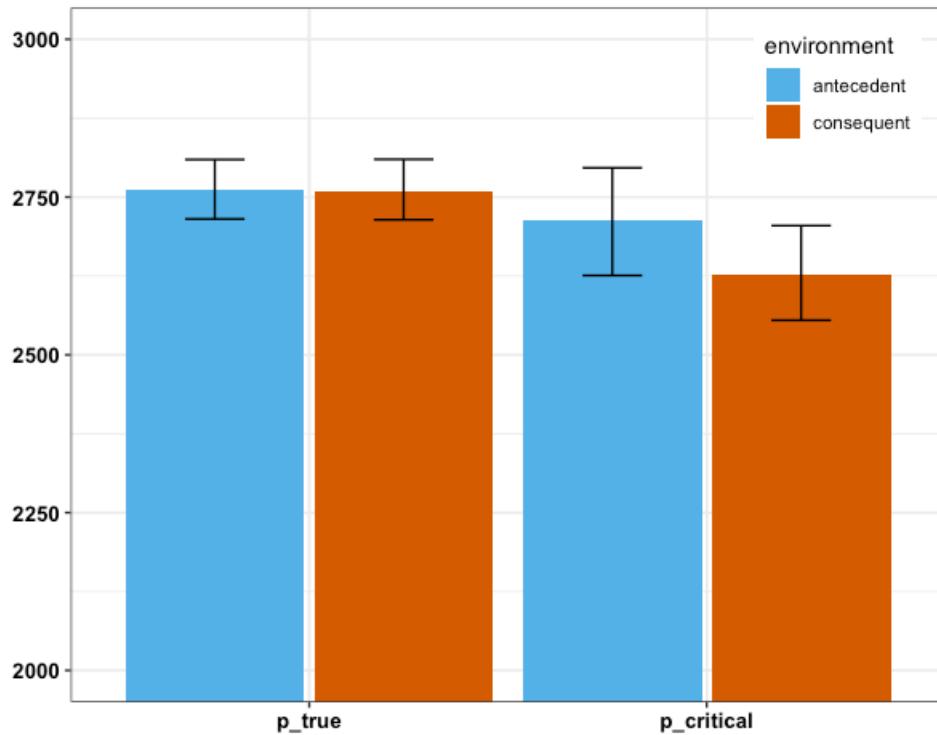


Table 2.12: Summary of RT analysis from Experiment 2

	Estimate	Std. Error	t	p
Intercept	7.90	0.05	158.81	<.001
Environment	-0.01	0.06	-0.17	0.87
Condition	-0.06	0.08	-0.80	0.42
Environment * Condition	0.03	0.05	0.61	0.54

Second, planned pairwise comparisons were performed between control, p_true, and p_critical. In particular, we are most interested in finding a significant difference

between p_critical_consequent and control, which would rule out the alternative interpretation that a False-Antecedent advantage is what underlies the processing of the conditionals with a false antecedent, thereby making our results uninformative with respect to how presuppositions in conditionals are processed. There was indeed a statistically significant difference between these two conditions ($t = 4.26$, $p < .001$), with p_critical_consequent yielding response times 211.85 ms longer than control for the “Yes” responses (Figure 2-7).

Figure 2-7: Comparing p_critical_consequent *vs.* non-presuppositional control

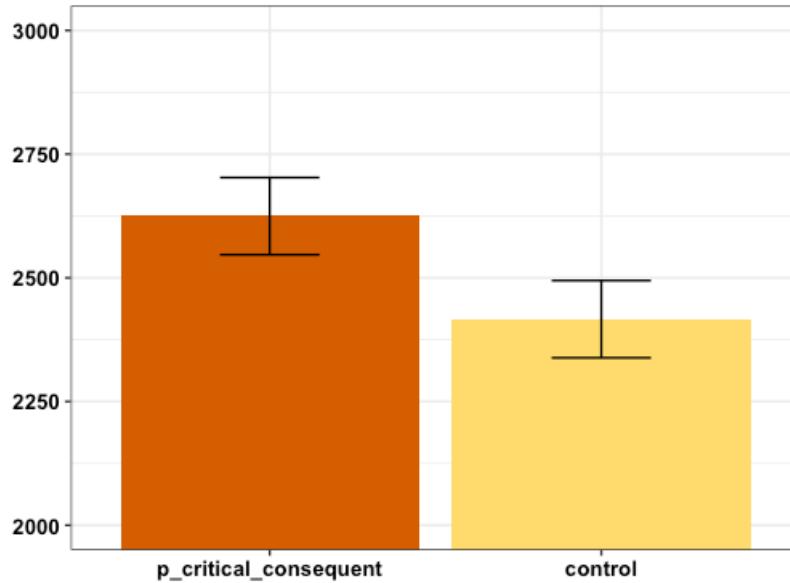


Table 2.13: Pairwise comparisons from Experiment 2

Contrast	<i>t</i>	<i>p</i>
p_critical_antecedent vs. control	5.12	<.001
p_critical_consequent vs. control	4.26	<.001
p_critical_antecedent vs. p_critical_consequent	1.22	0.22
p_true_antecedent vs. control	7.77	<.001
p_true_consequent vs. control	7.69	<.001
p_true_antecedent vs. p_true_consequent	0.12	0.90

Finally, as a post-hoc analysis, we also took a closer look at the environment-based difference (between Antecedent and Consequent) in the p_critical condition for each block of the experiment, with the hope that we may observe the time course

signature of local accommodation (Table 2.14); in other words, whether the costs associated with local accommodation diminish over the course of the experiment. We note that there are 3 stages: Stage 1 consists of the first two encounters of p_critical, during which there is a small (73.56 ms) or even reversed pattern (-150.41 ms) of the difference between Antecedent and Consequent; Stage 2 consists of the next 3 encounters, in the middle of the experiment, during which there is a substantial difference between Antecedent and Consequent in the expected direction (110 ms ~ 238 ms); Stage 3 is the final encounter, in which there is again a small difference between the environments (50.75 ms).

Table 2.14: Antecedent-Consequent Difference by order of encountering

Block Order	Trial Order	Antecedent RTs for Yes	Consequent RTs for Yes	Ant-Cons Difference
Block 1	1st	3069.02	2995.46	73.56
Block 3	2nd	2682.68	2833.09	-150.41
Block 4	3rd	2803.51	2565.39	238.12
Block 6	4th	2493.98	2384.30	109.68
Block 7	5th	2639.98	2451.14	188.84
Block 8	6th	2623.23	2572.47	50.75

2.2.2.4 Discussion

In Experiment 2, we found that there is an environment-based difference in the Yes-rates in the p_critical condition, with the Antecedent environment yielding lower Yes-rates than the Consequent environment. Although the Yes-rate difference between the Antecedent and the Consequent environment is numerically small in p_critical, it is a statistically meaningful difference in the expected direction. It is worth noting that, although our hypothesis concerns primarily a difference in response time, the design of our task crucially includes a 6-second timeout: participants must provide a Yes/No response within 6 seconds from the moment of seeing the outcome image, or their response would be recorded as NULL. This time limit could cause the responses that took excessively long to effectively lower the Yes-rates in the Antecedent environment.

Thus, once the timeout factor is taken into consideration, the difference we observed in Yes-rates is still very much compatible with our predictions under the asymmetric view.

Regarding the response time pattern for Yes-responses, we did not find a statistically significant interaction this time, although our results did reveal a numerical pattern that conforms to our prediction and our prior findings in Experiment 1: responding “Yes” to the Antecedent environment takes 87.12 ms longer than the Consequent environment in the p_critical condition, but this difference is only 1.68 ms in the p_true condition. More importantly, there is a substantial, 211.85 ms difference between p_critical_consequent and the control condition. This latter comparison addresses our previous concern from Experiment 1: in the current experiment with a block design, we cannot simply explain away the difference between Antecedent and Consequent as the result of an FA-advantage; had an FA-strategy been overwhelmingly adopted, we would not be able to observe any RT difference between p_critical_consequent and the control condition.

Why did we find a less robust effect in the response time data in Experiment 2? Below, I provide a discussion of two possible ways of understanding this given the materials and the block design.

Test sentences as proviso sentences?

For the present studies, we assume that a conditional presupposition is what arises in the Consequent environment, and no additional strengthening is involved there. We reasoned that in the setup of our experiments, it should be possible to assume a relationship between putting on any two mentioned clothes items, since this is a dress-up game where various kinds of fashion choices can be made. Specifically, it should be reasonable to consider it stylistic to put on a scarf if you also put on a coat. Thus, the semantic presupposition “if you put on a coat, you put on a scarf” should

surface also as the “felt” presupposition of the test sentences.

However, it is possible that the lack of robustness of the effect in Experiment 2 might have to do with the fact that our test sentences actually presented a case of the proviso problem. To see this, take (21) as a concrete example:

(21) If you give him a coat, the scarf you give him *has to* be striped.

- a. *If you give him a coat, there is a scarf you give him.*
- b. *There is a scarf you give him.*

Perhaps some participants interpreted (21) in the same way as they would for a sentence like “if John has free time, he will pick up his sister from the airport”. It is rather odd for a speaker to assume a common ground that entails something like “if John has free time, he has a sister”, and therefore a presupposition strengthening process can apply, with the non-conditional presupposition “John has a sister” arising as the “felt” presupposition. Similarly, for our test sentences like the one in (21), putting on a scarf is not typically seen as conditional on putting on a coat. Participants might thus get a proviso interpretation here as well, obtaining the non-conditional presupposition “there is a scarf given” (21-b) instead of the weak (21-a).

If this way of interpreting the test sentences was available in the experiment (at least for some participants), then we would expect that a non-conditional presupposition sometimes arose in the Consequent environment, just like the Antecedent environment. This could wash off some of the response time asymmetry that we sought after, since responding “Yes” in the consequent environment would then also require local accommodation. This could have led to the less robust effect found in Experiment 2. But this also means that the evidence for asymmetry has the potential of being even more robust, if the conditional presupposition was made even more plausible (e.g., putting on socks being conditional on putting on closed-toe shoes). The possibility of a proviso interpretation in our experimental setup deserves

a more thorough re-investigation in future work.

Side effect of the block design

Another possibility is to consider the lack of asymmetry as a side effect of the block design for conditional sentences with an FA. From the post-hoc analysis that reveals the time course of encountering a p_critical trial in each environment (Table 2.14), we see that the sought-after asymmetry is offset by a small or reversed difference in the first two blocks, and slightly so in the final block. We speculate this might have to do with the block design, in which the frequency of seeing an FA-trial was reduced, with a long interval between such trials. This might have introduced a third factor in the initial encounters of seeing a p_critical trial in Experiment 2: since FA-trials are much less “normalized”, after seeing only trials with a true antecedent in the conditional, participants were “stunned” in their first few encounters of an FA-trial, which runs counter to the expectations they have established for conditionals at this point. This might have washed off the effect of local accommodation in the first few encounters, but would eventually disappear as participants re-adjusted their expectations for how to respond to an FA-trial over the course of the experiment.

If this is on the right track, the environment-based asymmetry found during the middle of the experiment (3rd - 5th encounters) are more valuable in observing the extra cost associated with local accommodation, exactly in the direction we anticipated. Furthermore, as we learned from Zehr & Schwarz (2016), frequent access to local accommodation readings facilitates its application in later trials. Given this, it is not surprising that we eventually see the cost of local accommodation diminishing in the final, 6th counter at the end of the experiment, at which point participants might have developed anticipatory application of local accommodation.

2.3 From conditionals to disjunctions

Findings from Experiments 1-2 suggest that the basic, semantic presuppositions projected out of the antecedent and the consequent of *if*-conditionals are asymmetric. This has consequences for other linguistic environments: on the view that a projection “algorithm” is responsible for systematically deriving the projection across the board, we should expect to find further evidence of the same kind of asymmetric projection patterns, produced by the same algorithm in environments involving other binary connectives, such as conjunctions and disjunctions.

There has been some effort in using experimental approaches to determine whether presupposition filtering — how presuppositions fail to project when they are entailed by the local context — is asymmetric in conjunctions and disjunctions. For conjunctions, Mandelkern et al. (2020) conducted a series of experiments and argued that presupposition projection across conjunction is asymmetric. In a binary choice decision task, participants were presented with conjunctive sentences embedded inside the antecedent of *if*-conditionals that take the following form:³

- (22)
- a. If Mary used to do Jivamukti yoga and she stopped doing yoga, then Matthew will interview her for his story.
 - b. If Mary stopped doing yoga and she used to do Jivamukti yoga, then Matthew will interview her for his story.

Either the first or the second conjunct contained a presupposition trigger, in this case *stop*, while the other conjunct entailed the presupposition triggered by *stop*. Mandelkern et al. made sure that the entailment relation between conjuncts is asymmetric

³As Mandelkern et al. (2020) explains, in order to test for whether presuppositions *project* equally out of these minimal pairs, one cannot look at simple conjunctive sentences, because “the inference to the presupposition is licensed for both orders just given the logical nature of conjunction and the potential for accommodation”. Thus these conjunctive sentences were embedded under presupposition holes, e.g. in the antecedents of conditionals.

in order to control for independent issues of redundancy. Given the pair in (22), they reasoned that (22-a) is expected to not license the inference that *Mary used to do yoga*, since materials in the first conjunct can be used to filter out the presupposition inside the second conjunct. The key question is whether participants will endorse (22-b) as being able to license the inference that *Mary used to do yoga*, and if so, this would suggest asymmetry. The results showed that participants endorsed the said inference in (22-a) only 50% of the time, but in (22-b) the endorsement rate is significantly higher, at slightly above 75%. This pattern is replicated in an acceptability judgement task, in which the acceptability ratings for making the said inference in (22-b) received higher ratings compared to (22-a). Based on these findings, Mandelkern et al. argued that there is an asymmetry in presupposition projection from conjunction.

Empirical findings for disjunction, however, paint a more complicated picture. Early, classic examples in the literature, namely the “bathroom sentences”, appear to suggest that projection in disjunction is symmetric (Partee 2005):

- (23) a. Either the bathroom is in a funny place, or there is no bathroom.
 b. Either there is no bathroom, or the bathroom is in a funny place.

The presupposition triggered by the definite description, *the bathroom*, does not project in either (23-a) or (23-b), as both sentences are felicitous in contexts where there being a bathroom is not an already established fact. However, looking for projection asymmetry in pairs like (23) may not as straightforward as it might appear at first sight, due to the possibility that local accommodation may be invoked in such cases, leading to what appears to be a symmetric pattern in (23-a) and (23-b).

For this reason, Hirsch & Hackl (2014) notes that asking whether presuppositions can introduce admissibility conditions on the context of such disjunctions is not a reliable strategy to assess theories of presupposition projection. They proposed to

use a binary choice task with sentences that have the same profile as (23), but manipulated the context such that it never establishes the existence of a bathroom, but either does or does not give reasons for participants to expect so (Expected vs. Unexpected). Their results showed that participants are *less* likely to select disjunctive sentences with trigger in the 1st disjunct as natural in the Unexpected condition than in the Expected condition, compatible with the interpretation that a non-conditional presupposition is what projects in the 1st disjunct, but not the 2nd disjunct. These findings of projection asymmetry were further corroborated by processing evidence from a visual world eye-tracking paradigm in Hirsch, Zehr, & Schwarz (2018).

While Hirsch & Hackl (2014) and Hirsch, Zehr, & Schwarz (2018) both reported evidence of asymmetry in presupposition projection out of disjunctive sentences, Kalomoiros & Schwarz (2021a, 2021b) in recent work claimed that the processing of disjunction is symmetric. They adapted the paradigm from Mandelkern et al. (2020), but found no difference in acceptability judgements when the presupposition is embedded in the 1st *vs.* the 2nd disjunct, echoing findings of symmetry in an inference task by Chemla & Schlenker (2012) and sharply in contrast with Mandelkern et al.'s findings of asymmetry for conjunction. Based on the lack of evidence for asymmetry, they concluded that projection out of disjunction is symmetric, unlike conjunction.

Unfortunately, it is difficult to directly compare these findings as they use different experimental paradigms and materials. Our goal here will be to extend our own experimental paradigm, validated with a less controversial environment in Experiments 1-2, to systematically investigate how presuppositions project out of disjunctive sentences. Our approach differs from the previous work in that we do not rely on acceptability measures, but use response times as our main measure. On the asymmetric view, we expect to find longer response times when the trigger is in 1st disjunct, compared to the 2nd disjunct. We test this hypothesis in Experiment 3.

2.4 Processing presupposition in disjunctions

2.4.1 Experiment 3

2.4.1.1 Modification of the paradigm

Unembedded disjunctions typically trigger ignorance inferences about each individual disjunct, and the naturalness of these sentences require a context compatible with such inferences. For this reason, in Experiment 3, the overall narrative of our task changed from an assessment of instruction-adherence to a *prediction* task. Participants were told that a character (Sue) is making some guesses about what her friend (represented by a stick figure) will wear, and they were asked to evaluate whether Sue's guesses were born out in the outcome image.

The link between the behavior measure (outcome evaluation) and participants' interpretations of the presuppositional sentences is accordingly different in this experiment compared to Experiments 1-2. In Experiment 3, the participants first read a presuppositional disjunction "uttered" by an prediction-maker (the speaker, Sue), but this time, the participant themselves is the prediction-evaluator (i.e. the listener). Upon first reading the disjunctive sentence, the participants may assume that Sue has grounds for presupposing, e.g., that the friend would wear a coat, and accommodate that presupposition. But then the outcome image may reveal that she in fact, did not (e.g., because the stickman did not wear a coat even though the prediction sentence presupposed that a coat would be put on). At this point, the participants have two choices: (i) assume that Sue presupposed something unreasonable and thus made a wrong guess, because the stick figure did not put on an article of clothing that she took for granted that they would (resulting in a "No" response); (ii) assume that the intended reading of Sue's prediction was different from their own initial one, and access such a reading via local accommodation (resulting in a "Yes" response).

2.4.1.2 Design and materials

Experiment 3 used the same block design as Experiment 2, with Environment as a within-subject factor. In addition, our modification of the paradigm from the instruction mode to the prediction mode results in removing the modals *have/has to*, which in a way simplifies the materials compared to Experiments 1-2. The resulting sample materials for Experiment 3 can be found in Table 2.15. Other aspects of the task remain the same as before.

Table 2.15: Sample materials for Experiment 3

Condition	Outcome Image	Environment (Trigger Position)	
		1 st Disjunct	2 nd Disjunct
Consistent across conditions		He has an umbrella.	
	p_true	The socks he wears are red, or he wears a scarf.	He wears a scarf, or the socks he wears are red.
	p_critical	The gloves he wears are blue, or he wears socks.	He wears socks, or the gloves he wears are blue.

Throughout the experiment, disjunctive sentences were created without “either”.

Two target trial types are included:

- **p_true**: predictions based on the embedded presupposition (e.g., that there are socks he wears) are born out in the dress-up; clothing items mentioned in either the 1st disjunct or the 2nd disjunct appears in the dress-up. Participants are expected to arrive at a “Yes” response.
- **p_critical**: predictions based on the embedded presupposition (e.g., that there are gloves he wears) are not born out in the dress-up. The presupposed clothing does not appear on the stick figure in the dress-up; only the non-presupposed one does. The trigger is either in the 1st disjunct or the 2nd disjunct.

We also included the following filler items:

- **p_false**: These fillers involve presuppositional disjunctive sentence. The pre-

supposed clothing item appears on the stickman, but is in the wrong color, and the item mentioned in the non-presuppositional disjunct does not appear. Participants are expected to arrive at a “No” response.

- **Non-presuppositional disjunction, OneDisjunct:** These disjunctive fillers do not carry a presupposition. Only the clothing item mentioned in one of the disjunct appears in the dress-up. Participants are expected to arrive at a “Yes” response.
- **Non-presuppositional disjunction, BothDisjuncts:** These disjunctive fillers do not carry a presupposition. Clothing items mentioned in both disjuncts appear in the dress-up, compatible with an “inclusive” reading of *or*. Participants received training with explicit feedback that this is acceptable and thus are expected to arrive at a “Yes” response.
- **Non-presuppositional disjunction, NeitherDisjunct:** These disjunctive fillers do not carry a presupposition. Clothing items mentioned in neither disjunct appear in the outcome image. Participants are expected to arrive at a “No” response.
- **NeitherNor:** These filler sentences take the form of “He has neither *Object*₁ nor *Object*₂”, and one of these clothing items appears in the outcome image. Participants are expected to arrive at a “No” response.

Every block contained 7 trials: beginning with a mix of 6 non-critical trials, and ending with a critical trial that is either p_critical_1stDisjunct or p_critical_2ndDisjunct (Table 2.16). here were 8 blocks, yielding a total of 56 trials. The order of the blocks and the order of non-critical trials within each block were the same for all participants. The total number of Yes/No expected responses in the entire study was counterbalanced. In addition, we counterbalanced the order of environment in the initial block by creating 2 versions of the experiment for testing, 1stDisjunct_First and 2ndDisjunct_First.

Table 2.16: Sample workflow for the block design

	Sequence of 6 trials	Critical trial
Block 1	p_true, p_false, 3 * non-presuppositional fillers, NeitherNor filler	p_critical: trigger in 1st Disjunct
Block 2	p_true, p_false, 3 * non-presuppositional fillers, NeitherNor filler	p_critical: trigger in 2nd Disjunct

The experiment began with 7 practice trials, for which explicit feedback was provided to the participants. Two training trials were included to ensure that participants understood that the inclusive reading of *or* is acceptable:

- (24) Training item: I bet he wears pants. He wears a tie, or he wears a shirt.
 Stick figure wears: pants, a tie, a shirt
 Expected response: Yes (Sue's guess is accurate)

Participants must answer all training trials correctly in order to proceed. Afterwards, the order of all blocks and trials within a block remained the same for all participants.

2.4.1.3 Data collection

150 participants were recruited on Prolific. The sample size is based on our Experiment 2, which also had a block design and had Environment as a within-subject factor. Experiment 3 included 8 p_critical trials for each participant, totaling 1,200 observations. We aimed to obtain 600 observations for each environment in Experiment 3, thus 150 participants, which brought us to the same number of observations for each of the critical conditions in Experiment 2. The same exclusion criteria as before applied.

2.4.1.4 Results and analyses

Performance on all filler items was at-ceiling, indicating that our participants paid attention during the experiment. The accuracy rates for these filler items are summarized in Table 2.17.

Table 2.17: Performance on filler items from Experiment 3

Condition	Accuracy rates
p_false, 1st Disjunct	98.49%
p_false, 2nd Disjunct	98.31%
NeitherNor, 1st Disjunct	95.45%
NeitherNor, 2nd Disjunct	97.12%
Non-presuppositional, 1st Disjunct given	98.64%
Non-presuppositional, 2nd Disjunct given	97.82%
Non-presuppositional, both Disjuncts given	94.56%
Non-presuppositional, neither Disjunct given	98.82%

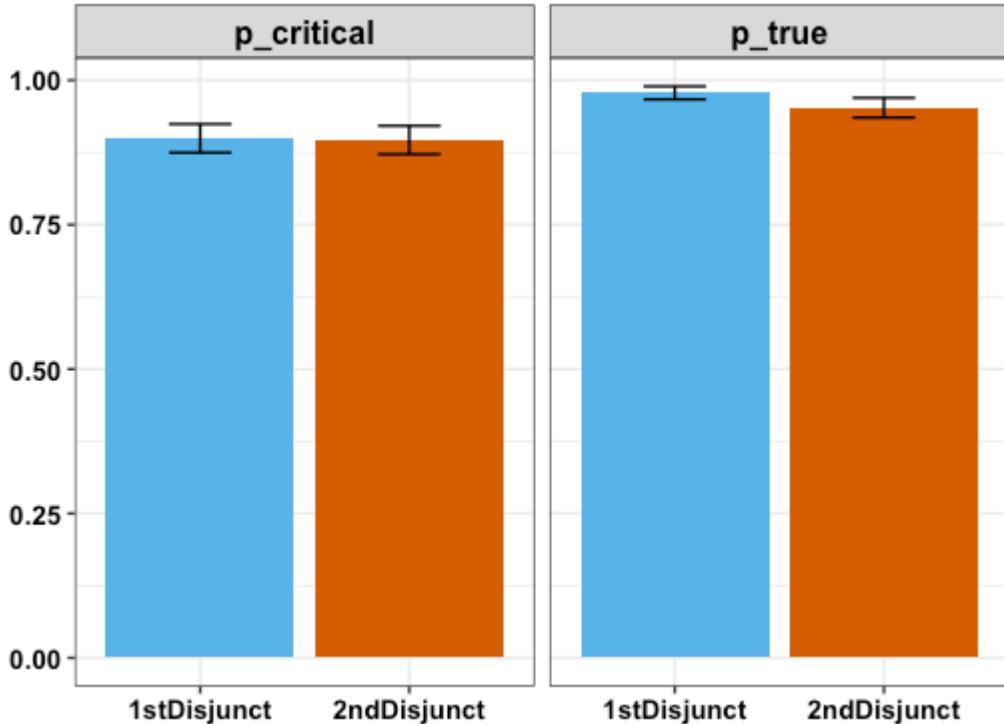
In particular, the non-presuppositional fillers in which clothing items from both disjuncts are given received slightly lower accuracy rates compared to the other filler types (94.57%). This is due to 5 participants who responded “No” to this filler condition more than 50% of the time, indicating that they rejected the inclusive reading of *or* despite explicit training; a subset of these participants also left post-experiment comments saying that they believed the inclusive reading from the training is “actually grammatically incorrect”. These participants were removed for the rest of the analysis.

For the two target conditions, their Yes-rates and times taken to arrive at a “Yes” response are summarized below in Table 2.18. For Yes-rates (plotted in Figure 2-8), overall there were more “Yes” responses in the p_true condition compared to the p_critical condition: the former yielded above 95% Yes-rates in both the 1st Disjunct and the 2nd Disjunct environments, whereas the latter yielded Yes-rates slightly lower than 90%. The Yes-rates are 2.64% higher in the 1st Disjunct environment than the 2nd Disjunct environment for p_true, and almost identical across the two environments for p_critical.

Table 2.18: Results from Experiment 3

	Yes-rates	RTs for Yes responses (ms)
p_true, 1st Disjunct	97.91%	2534.07
p_true, 2nd Disjunct	95.33%	2690.02
p_critical, 1st Disjunct	89.95%	2891.01
p_critical, 2nd Disjunct	89.65%	2749.51

Figure 2-8: Yes-response rates in Experiment 3 (N=150)



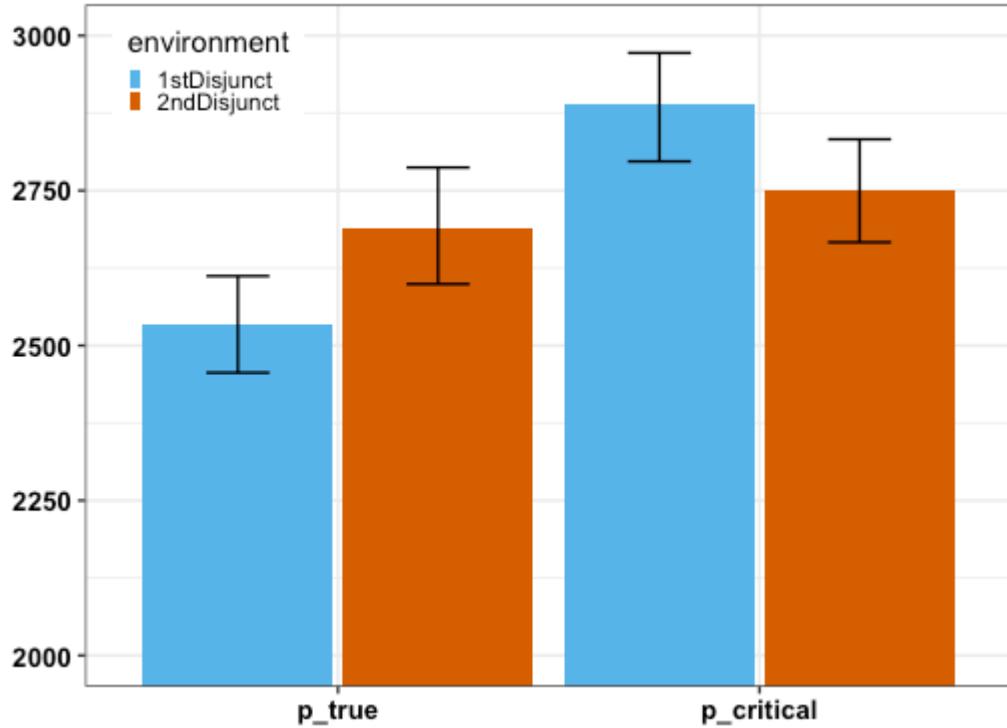
The data including only p_true and p_critical conditions was fit into a mixed-effects logistic regression model, using the same method as in Experiments 1-2. The model that converged with maximally specified random structure revealed a significant main effect of Environment ($z = 2.15$, $p < .05$), and a marginally significant interaction between Environment and Condition ($z = -1.68$, $p = .09$). This is due to the environment-based difference in the Yes-rates in the p_true condition, with the Antecedent environment yielding higher Yes-rates than the Consequent environment (though numerically small), which drives the marginal significant interaction observed in the Yes-response data.

Table 2.19: Summary of Yes-rates analysis from Experiment 3

	Estimate	Std. Error	<i>z</i>	<i>p</i>
Intercept	3.57	0.40	8.88	<.001
Environment	1.32	0.61	2.15	0.03
Condition	-0.80	0.49	-1.62	0.11
Environment * Condition	-1.07	0.64	-1.68	0.09

For the response time data for Yes-responses (Figure 2-9), we again fit the data into a generalized mixed-effect model with a log distribution using the same methods as previous experiments. The model that converged with maximally specified random structure revealed a significant interaction between Environment and Condition ($t = 2.60$, $p < .01$) (Table 2.20).

Figure 2-9: Response time for Yes-responses in Experiment 3 (N=150)



Finally, we also looked at the environment-based difference (between Antecedent and Consequent) in the p_{critical} condition for each block of the experiment (Table 2.21), in search for the time course signature of local accommodation that might corroborate our interpretation of the results in Experiment 2. We note that there

Table 2.20: Summary of response time analysis from Experiment 3

	Estimate	Std. Error	t	p
Intercept	7.85	0.05	172.67	<.001
Environment	-0.06	0.04	-1.35	0.18
Condition	0.04	0.05	0.83	0.41
Environment * Condition	0.11	0.04	2.60	<.01

are two distinct stages: there were substantial response time differences in the expected direction between environments for the first 6 blocks, with 1st Disjunct always yielding longer response times than 2nd Disjunct; in the final 2 blocks, these differences disappeared (and in fact went into the reversed direction). This is reminiscent of the time course we observed in Experiment 2 (see Table 2.14): a stage in which the predicted environment-based asymmetry sustained, followed by the asymmetry diminishing at the end.

Table 2.21: Antecedent-Consequent Difference by order of encountering

Order	1st Disjunct RTs for Yes	2nd Disjunct RTs for Yes	Ant-Cons Difference
Block 1	3387.31	3049.65	337.66
Block 2	3138.20	2850.67	287.53
Block 3	2801.03	2638.00	163.03
Block 4	2907.34	2515.55	391.79
Block 5	2879.35	2477.67	401.68
Block 6	2916.09	2679.43	236.66
Block 7	2577.15	2978.81	-401.66
Block 8	2676.15	2895.2	-219.05

2.4.1.5 Discussion

In Experiment 3, we first observed a small environment-based difference in the Yes-rates in the p_true condition, with the 1st Disjunct environment yielding higher Yes-rates than the 2nd Disjunct environment. Relatedly, responding “Yes” in the 1st Disjunct environment took 155.95 ms shorter than the 2nd Disjunct environment. Such an environment-based difference in the p_true condition is something we did not

observe in the *if*-conditionals, but we believe this can be explained once we take into consideration our design for disjunctions. Specifically, we created training and testing materials to encourage an “inclusive” interpretation of the disjunctive *or*. Given (the successful implementation of) this, upon seeing the outcome image, participants could already anticipate responding “Yes” after they identified that the clothing item mentioned in the first disjunct appears in the outcome for p_true:

- (25) a. The socks he wears are red, or he wears a scarf

Outcome: red socks, but no scarf.

- b. He wears a scarf, or the socks he wears are red.

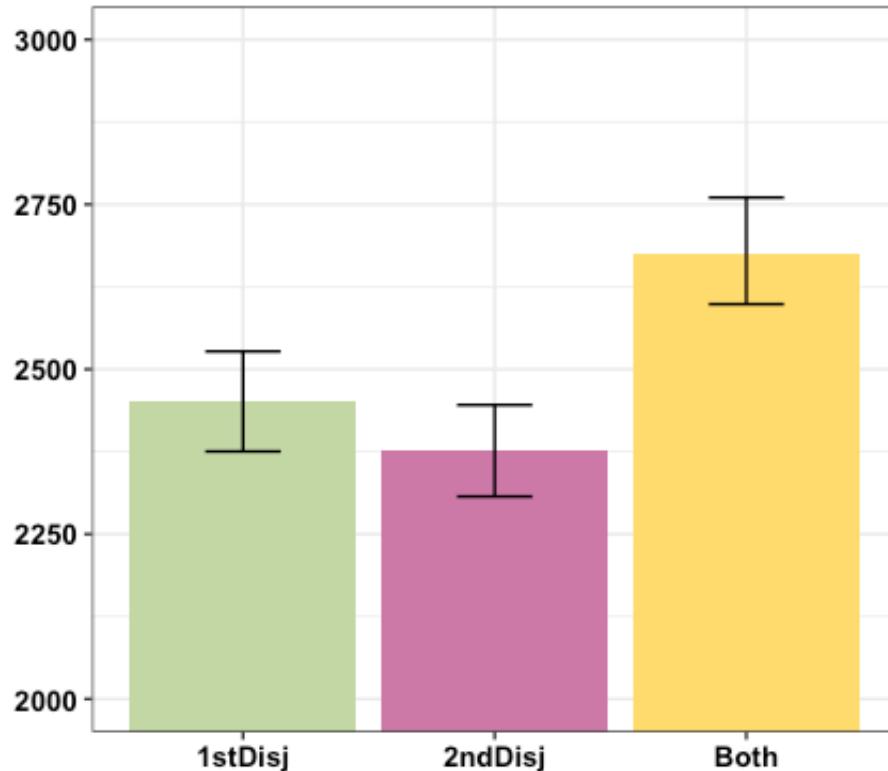
Outcome: no scarf, but red socks.

Thus, responding “Yes” to the p_true condition when the clothing item mentioned in the 1st disjunct appears in the outcome (25-a) is easier, resulting in the higher Yes-rates and shorter response times in the 1st Disjunct condition. By contrast, for the 2nd Disjunct condition (25-b), participants first check that in the dress-up, the stick figure does not wear a scarf. At this point, they still could not make a decision as to whether the guess was accurate, because they still needed to check whether the clothing item mentioned in the 2nd disjunct appears or not.

For the p_critical condition, the presupposed item does not appear on the outcome scene in either the 1st Disjunct or the 2nd Disjunct condition. On the asymmetric view of projection, the sentences where the trigger is in the 2nd Disjunct can still be seen as having been a good guess about the outcome. However, if the trigger was in the 1st Disjunct, it can be seen as a good guess only on a local accommodation reading. We indeed found an environment-based difference in the times taken to arrive at a “Yes” response in p_critical, with longer response times associated with 1st Disjunct compared to 2nd Disjunct, which we take to reflect the asymmetric application of local accommodation.

Can this difference be taken to reflect a partial reading strategy akin to what we discussed for Experiments 1-2, e.g., reading only the 1st disjunct? We have two reasons to believe that that is not the case. First, in the case of `p_critical_2ndDisjunct`, if the response times only reflected the processing of its 1st disjunct, we would have observed similar or even shorter response times compared to `p_true_1stDisjunct`, since both of them have a first disjunct whose clothing item appears in the outcome. But this is not the case: the times taken to say “Yes” to `p_critical_2ndDisjunct` are in fact 215ms longer, suggesting that a strategy relying on piecemeal processing cannot explain the pattern we see in `p_critical`. Second, if such a strategy was predominant, we should be able to find indications of it in the presupposition-less controls as well. But there were no such indications, as we can see in Figure 2-10 (the labels indicate the disjunct(s) in which the mentioned clothing item appears in the outcome image).

Figure 2-10: Response times in presuppositionless controls in Experiment 3



The prediction should be considered accurate for each of these cases. But if the partic-

ipants *only* considered the 1st disjunct they encountered, and moved on immediately after they identified that they could respond “Yes” by this point, then we would expect to find two things: (i) the 1st Disjunct controls would yield shorter RTs than the 2nd Disjunct controls; (ii) the 1st Disjunct controls and the Both Disjunct controls would yield similar RTs. Neither was born out in the results. We can therefore rule out a shallower alternative explanation for our data.

Taken together, the results from Experiment 3 are compatible with the interpretation that (i) there is an asymmetric pattern of presupposition projection in disjunction, with asymmetric response time latencies in the 1st disjunct suggesting recruitment of local accommodation only in that environment; (ii) the application of local accommodation can be primed, and in a block design, and the preemptive application develops over the course of the experiment; (iii) *if*-conditionals and disjunctions have some pragmatic differences that may introduce third factors into testing the processing of these constructions, but the underlying semantic projection pattern is shared across these two connectives. Together, the results are compatible with the idea of a projection algorithm (rather than piecemeal, or lexically-specified projection rules) responsible for systematically deriving the presupposition of a complex construction compositionally based on presuppositions of its subpart, and that this algorithm yields an asymmetry in what projects from the two arguments of binary connectives.

2.5 General Discussion

2.5.1 Summary of findings

In this chapter, we set out to investigate the processing of presupposition projection out of two binary connectives, *if* and *or*. We carried out a series of behavioral experiments in which adult participants were asked to evaluate presuppositional sentences

— provided either as an instruction or as a prediction — against an outcome image. In the critical cases, a presupposition trigger is embedded either in the left or the right argument of a binary connective, and the presupposed item does not appear in the outcome scene, which has diverging consequences on the processing costs associated with each environment under the asymmetric view of presupposition projection. Without further adjustments, a presupposition triggered in the antecedent of a conditional or the 1st disjunct in a disjunctive sentence simply becomes the presupposition of the entire construction. So, treating an outcome that lacks the presupposed item as compatible with such a sentences is possible only if one locally accommodates the relevant presupposition, a process that, by hypothesis, should incur a processing cost. In contrast, presuppositions triggered in the consequent of a conditional or the 2nd disjunct in a disjunction do not get inherited as is; the entire sentence is associated with a weaker, conditionalized presupposition. In these cases, endorsing an outcome lacking the presupposed item is straightforward and does not require any additional processes. This leads to a prediction of asymmetric processing costs across environments on the asymmetric view of projection.

This prediction was born out. The studies presented in this chapter demonstrated an asymmetry in how participants responded to presuppositions triggered in the left vs. right arguments of *if* and *or*. We consistently found longer response times when an outcome scene failed to include an item described by a presuppositional expression in the left argument (antecedent, 1st disjunct). This is consistent with the idea that such cases require a different, and more costly, re-interpretation of the sentences that effectively “gets rid of” the presupposition. In what follows, I discuss the theoretical and methodological implications of these findings.

2.5.2 Asymmetric projection and asymmetric theories

We used comparable experimental paradigms and materials to study presupposition projection out of two different connectives, *if* and *or*. This allowed us to directly compare the projection patterns across the two connectives, while identifying third factors that come into play in the processing of each. But once we take the third factors into account, either by controlling for potential confounds in a revised design (from Experiment 1 to Experiment 2) or by evaluating how they impact the interpretation of our results (Experiment 3), the best way of explaining our data patterns is by making reference to asymmetric application of local accommodation, and in turn, an asymmetric theory of presupposition projection.

A recap of all the experimental findings can be found in Table 2.22.

Table 2.22: Summary of experimental findings

	Yes-rates	Response Times for Yes
<i>if</i> -conditional	No asymmetry in Exp 1, Asymmetry in Exp 2	Asymmetry in Exp 1, numerical trend in Exp 2
disjunction	No asymmetry in Exp 3	Asymmetry in Exp 3

These results are most compatible with a view in which the projection patterns in these constructions are underlying asymmetric, with a conditional presupposition projecting from the consequent/2nd disjunct, but a non-conditional presupposition projecting from the antecedent/1st disjunct. They are difficult to explain on the symmetric view of projection, which predict, at least as a default, non-conditional presuppositions for both trigger positions. This should force the recruitment of local accommodation across-the-board, then, to render the outcome compatible with the presuppositional sentence. But that would fail to explain the processing asymmetry we observe, without auxiliary assumptions. What might such an assumption look like, if one wanted rescue the symmetric view? Perhaps the processing cost of applying local accommodation is greater in the antecedent than the consequent in the case of *if*-conditionals; likewise for the 1st disjunct than the 2nd disjunct. Such an additional

assumption may explain this specific pattern of results, but as far as we are aware, there is no independent evidence and little motivation for making an assumption like this.

Furthermore, connecting our results from *if*-conditionals and disjunctions with Mandelkern et al.'s (2020) finding of asymmetric projection out of conjunctions, we are now looking at a uniform projection pattern across all three binary connectives. This provides additional arguments in favor of the view that a projection algorithm is responsible for deriving the presuppositions of complex sentences based on the presuppositions of its parts, contrary to an alternative approach that derives projection patterns from lexical properties of individual connectives. Since the presuppositions project asymmetrically from *if*-conditionals, disjunctions, and conjunctions, a favorable explanation will be one that posits a general projection algorithm that predicts the same asymmetric pattern for all connectives, rather than an approach that attempts to capture the projection behavior of each connective separately.

2.5.3 Processing debates: finding (a)symmetry in disjunctions

Our investigation of presupposition projection also has important implications for the study of presupposition processing using experimental methods. In recent years, there has been a surge of psycholinguistic work investigating various aspects of the processing of presupposition, covering a wide range of triggers and phenomena and in a variety of languages (for overviews, see Schwarz 2015, Schwarz 2019, Göbel 2020). As already discussed, some of this work focuses on the processing effects of presupposition projection.⁴ Like the present work, there have been attempts to clarify whether presupposition projection from connectives is symmetric or asymmetric, but

⁴Chemla & Schlenker (2012), Chemla & Bott (2013), Schwarz & Tiemann (2013), Schwarz & Tiemann (2017), Hirsch & Hackl (2014), Hirsch, Zehr & Schwarz (2018), Mandelkern et al. (2020), Kalomoiros & Schwarz (2021a, 2021b); for an overview, see Schwarz (2016).

as we mentioned, existing findings are mixed, especially in the case of disjunction (Chemla & Schlenker 2012; Hirsch & Hackl 2014; Hirsch, Zehr & Schwarz 2018; Mandelkern et al. 2020; Kalomoiros & Schwarz 2021a, 2021b). As we mentioned in Section 3, Hirsch & Hackl (2014) and Hirsch et al (2018) both reported evidence of asymmetry in the projection patterns, but Chemla & Schlenker (2012) and Kalomoiros & Schwarz (2021a, 2021b) argued that there is no evidence for asymmetric projection in disjunction. Our findings come down on the side of asymmetry, but it is worth considering why experimental results have been conflicting.

To begin, we agree with Hirsch and Hackl (2014) that simply asking whether presuppositions can introduce admissibility conditions on the context of complex constructions is not always a reliable strategy to assess theories of projection, precisely due to confounds introduced by processes like local accommodation. Much of the processing work on the topic rely on offline data, making it difficult to determine whether a given judgment reflected the semantic presupposition alone, or some additional process.

We can also offer some speculations about the lack of asymmetry reported in Kalomoiros & Schwarz (2021a, 2021b). As part of their experimental materials, Kalomoiros & Schwarz (2021a) paired the disjunctive sentences with minimally different conjunctions. This could have had unintended consequences for presupposition projection.

In recent work on the proviso problem, Mayr & Romoli (2016) attempts to tie presupposition strengthening to implicature. Assuming a grammatical theory of exhaustivity implicature (Fox 2007; Chierchia, Fox & Spector 2012; a.o.) and a Strong Kleene logic for presupposition projection, they argue that symmetry is precisely what is predicted on a perfected interpretation of *if*-conditionals or an exclusive interpretation of disjunctions. To see why, it is useful to look at their formal implementation for disjunction. They adopt the exhaustivity operator defined in (26-a) (Fox 2007; Chier-

chia, Fox & Spector 2012; a.o.) and assume the standard alternatives as in (26-b). The exhaustivity operator, when applied to the prejacent, asserts it and negates its excludable alternatives, as shown in (26-c):

- (26) a. $\text{EXH}(\text{ALT}(p))(p)(w) = p(w) \wedge \forall q \in \text{EXCL}(p, \text{ALT}(p))[\neg q(w)]$
- b. $\text{ALT}(A \rightarrow B) = \text{ALT}(\neg A \vee B) = \{\neg A \vee B, \neg A, B, \neg A \wedge B\}$
- c. $\text{EXCL}(p, \text{ALT}(p)) = \{q \in \text{ALT}(p) : p \notin q \wedge \neg \exists r[r \in \text{ALT}(p) \wedge (p \wedge \neg q) \subseteq r]\}$

For disjunction, the exhaustivity operator will negate the conjunctive alternative yielding an exclusive interpretation (27-a). Mayr & Romoli then showed that by applying the Strong Kleene logic for exclusive disjunctions, we can derive that presuppositions will project non-conditionally from both arguments of *or*:

- (27) a. Exclusive disjunction: $\text{EXH}(\neg A \vee B) = (\neg A \vee B) \wedge \neg(\neg A \wedge B)$
- b. Projection: $\text{EXH}(A \vee B_p) = \text{EXH}(\neg A \rightarrow B_p) = (A \vee B_p) \wedge \neg(A \wedge B_p)$
 $\rightsquigarrow p$

Such an account involving the role of exhaustivity makes interesting predictions for both *if*-conditionals and disjunctions. Even assuming that the underlying projection pattern is asymmetric in nature, we may simply fail to detect asymmetry if a perfected interpretation of *if*-conditionals or an exclusive interpretation of disjunctions is highly salient in a task.

It is possible that an exclusive interpretation of *or* might have been easily induced, if not forced, by the presence of conjunctive sentences in Kalomoirs & Schwarz's experiment, which make the stronger alternative to the disjunctive sentences salient. If the exclusive interpretation of disjunction was salient for the participants, it might have led to a strengthened interpretation of presupposition in the 2nd disjunct environment, if we take Mayr & Romoli's proposal seriously. This could have then yielded

the surface symmetry. If this is right, simply encouraging the exclusive reading in our task may result in an entirely different pattern of results from Experiment 3. We can test this hypothesis by carrying out a close variant of Experiment 3 that includes the following changes. First, remove the training items which encourage an inclusive interpretation of *or*. Second, include 4 conjunctive filler items (to replace the 4 inclusive *or* items in Experiment 3) that are minimally different from the disjunctive items. The idea is that the inclusion of conjunctive alternatives facilitates the computation of exclusivity implicatures.⁵ An investigation along these lines is underway.

2.6 Conclusion

In a set of processing studies with adults, we showed that participants respond differently to presuppositions triggered in the left and right arguments of binary connectives. We took these results to lend support for the asymmetric view of presupposition projection, on which only presuppositions triggered in the left argument become presuppositions of the sentence on the whole. Our study presents a further argument for using online processing measures to detect variations in the means we take to arrive at interpretations of presuppositional sentences. The recruitment of presupposition-cancellation mechanisms are costly, and this cost is detectable in participants' response times even when the intuitive judgments themselves are subtle.

⁵There might also be other ways to induce the exclusive reading: by including “either” (Hendriks 2003), via visual means (capitalizing “OR”) or prosodic means (contrastive stress), as shown in Chevallier et al (2008).

Chapter 3

Acquisition of Presupposition Projection

3.1 Introduction

In Chapter 2, a series of behavioral experiments with English-speaking adults were carried out, and the results revealed a processing asymmetry compatible with the idea that presuppositions project conditionally from the right argument of binary connectives. In the present chapter, we extend our investigation to child language.

Our motivations for looking at child language data are two-fold. The first is to corroborate our evidence from the previous chapter. A remaining concern from the processing experiments was the possibility that adult participants, incentivized to complete the task quickly, might adopt a linear-order based strategy to read or process the test sentences partially. With subsequent controls, we were able to reject such task-based explanations conclusively for disjunction, but less conclusively for conditionals. But the evidence of asymmetry in this environment can be strengthened if we find an asymmetry in child language data, especially as tasks with young children are not amenable to reading-based strategies. Second, and more significantly,

child language provides an environment where the basic, semantic presuppositions of sentences might be more easily detected. This is because children have been argued to apply presupposition-cancelling mechanisms such as local accommodation at lower rates than adults (Bill et al. 2016; Zehr et al. 2016; Tieu et al. 2018). If so, a major confound that makes it hard to detect the underlying projection patterns in adults is reduced in child language, making the semantic presupposition of complex sentences more transparent there. I will elaborate on this point in the next section.

In addition to addressing our theoretical question, another goal of this acquisition work is descriptive. Presupposition projection has been a generally understudied topic, and to our knowledge, there has not been a study on projection out of binary connectives. Thus, this work also aims to fill an empirical gap in the literature.

The rest of this chapter will be organized as follows. Section 2 offers a brief review of existing developmental research that is pertinent to the present work. In Section 3, we report an experiment investigating children’s understanding of presupposition projection in *if*-conditionals, finding an environment-based asymmetry for 5-year-olds. In Section 4, we propose an extension of the experiment to disjunctive sentences. Section 5 closes with a general discussion of the child experiment(s) in connection with the adults experiments.

3.2 Previous developmental work on projection and (local) accommodation

Previous developmental research on presupposition has demonstrated early adult-like understanding of a variety of presupposition triggers (e.g., Schulz 2003, Syrett et al. 2010, Dudley et al. 2015, Dudley et al. 2017, Dudley 2017, Jasbi 2016) and a general understanding of how presuppositions relate to the context of use (Aravind 2018). Of further relevance for our purposes is the demonstration that children have

an adult-like understanding of the existence presupposition of definite descriptions, the presupposition trigger we use in our experiments, at least by age 4 (Wexler 2003, Aravind 2018).

Children’s treatment of presuppositions in *embedded* environments, on the other hand, has received less attention. To my knowledge, there is no study examining children’s understanding of how presuppositions project from binary connectives. However, there has been a few studies on children’s knowledge of presupposition projection from negative environments and question environments (Schulz 2003, Dudley et al. 2015; Bill et al. 2016; Jasbi 2016; Zehr et al., 2016; Aravind & Hackl, 2017), which may give us a sense of the general trajectory of presupposition projection in this population. The overall picture is of selective mastery. While children, for the large part, behave like adults when it comes to projection from Yes/No questions and negation (Schulz (2003), Aravind & Hackl, 2017), others found that preschoolers do not behave like adults when it comes to projection from the scope of a negative quantifier *none* (Zehr et al. 2016).

In one study in particular, Bill et al. (2016) used the Covered Box paradigm (Huang et al. 2013) to investigate children’s behavior with the presupposition trigger *win* in the scope of negation. Children were asked to choose between a visible picture and an occluded one that best described a test sentence like (28), which presupposes that the bear *participated* in the race. The visible picture depicted a bear who did not participate in the race. Because (28) would incur a presupposition failure in that situation, the adult-like choice would be the masked picture.

- (28) The bear didn’t win the race.

Presupposes: The bear participated in the race.

Four- and five-year-old children overwhelmingly preferred the covered picture, suggesting that they understood that the presupposition of *win* projects through nega-

tion. 7-year-old children showed significantly fewer covered picture choices than 4-year-olds and 5-year-olds, but crucially, their behavior was in fact closer to the adults, who selected the covered picture only about 30% of the times. Bill et al. (2016) reasoned that adults, and to some extent 7-year-olds, are able to cancel or suspend the presupposition under negation through the additional mechanism of local accommodation, which generates the interpretation in (29-a) and allows for a continuation like the one in (29-b):

- (29) a. It's not true that [the bear participated and won]
b. The bear didn't win the race.....he didn't even participate!

By contrast, the younger children at the age of 4 and 5 were less likely to endorse a choice that is compatible with the reading in (29-a), which is taken to suggest that they are less likely to recruit the additional mechanism of local accommodation. Bill et al. (2016) further suggested that this connects well with existing findings which show that the readings that involve local accommodation are more costly during real-time processing, and since children are not fully developed in terms of their processing capacities, they naturally are less proficient in applying local accommodation.

If Bill et al.'s (2016) interpretation is on the right track, then one of the potential confounds that may lead to the observation of overly weak projection patterns — local accommodation — is minimized in this children younger than 7. In this sense, child language data may provide an opportunity to observe presupposition projection patterns much more transparently. Children may be less likely to “rescue” what would otherwise be a presupposition failure via local accommodation, giving us a chance to detect instances of presupposition failure. With bivalent connectives, detection of presupposition failure becomes critical precisely because different theories make different predictions about when one should arise. For instance, theories diverge on when the use of a conditional of the form *If* ϕ , ψ_p is felicitous. The context needs to

meet a weaker criterion on the asymmetric theories (it should entail $If \phi, p$) compared to the symmetric theories (it should entail p). In the study presented below, we ask how children respond to sentences of this form when r is not supported by the context.

3.3 Experiment 4: Acquisition of projection in *if*-conditionals

In our first child experiment, we probe childrens expectations about presupposition projection from the antecedent and consequent of conditional sentences.

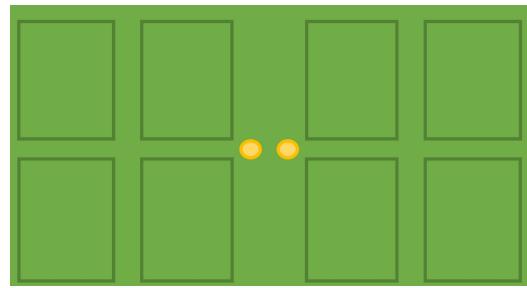
3.3.1 Design and materials

We use a child-friendly variant of the Outcome Evaluation Task (see Chapter 2, Section 2.2.1 for a detailed discussion on the logic of the task). In this “dress-up” game, a cartoon character (a bear) was instructed to put on a certain set of clothes. The child was told that the bear was not always very good at following instructions, and so she may get something wrong, and it was the child’s job to tell her if she did a good job following instructions or not. However, the bear is “very picky” about her style, so the child should *not* change anything unless it really helps the bear follow the instructions.

At the start of each trial, an experimenter introduced the clothing items in the closet (Figure 1a), and then provided the test sentences as instructions to the bear. The door then closed as the bear was getting changed (Figure 1b). When it opened again, the outcome was presented to the child participant (Figure 1c) and the test sentences were repeated. The child was then asked if the bear followed instructions, part of which was a presuppositional conditional. If not, the child was invited to fix it. Child participants received a star for helping the bear regardless of what their response was (Figure 1d)



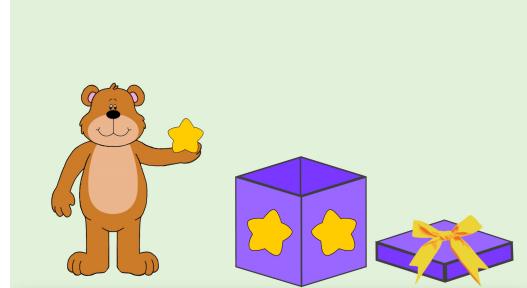
(a) Scene 1: Closet



(b) Scene 2: Door closed



(c) Scene 3: Outcome



(d) Scene 4: Reward

Figure 3-1: Workflow of a critical trial

The experiment began with a training phase. There were 4 training trials in total, two of which have Yes as the expected response and the other two No as the expected response. The child received feedback (with scaffolding if necessary) during the training phase. The goal of training was to make sure the child understood the basics of the task: that the bear doesn't always get it right or wrong, that they could give the bear items from the closet as well as removing items from the bear, that they did not have to give the bear every piece of clothing mentioned in the test sentences (e.g., such as (30)), and that nothing should be changed so long as the instructions were already being followed.

- (30) Training trial: You can put on a shirt, but it's okay if you don't. You can put on pants, but it's okay if you don't. But if you put on BOTH a shirt and pants, you have to put on shoes.

Closet provides: shirt, pants, shoes

The bear wears: pants

Figure 3-2: Outcome scene for a sample training trial (conditional)



Our critical trials were intended to detect the presupposition projected out of conditionals. Crucially, the item described by embedded presupposition trigger (underlined), a scarf, does not appear in the outcome of the bear's dress-up (Ex (31) and Ex (32)).

- (31) Critical trial (Antecedent): You have to put on a coat. If the scarf you put on is striped, you do have to put on shoes.

Closet provides: striped scarf, green scarf, shoes, coat

The bear wears: coat

- (32) Critical trial (Consequent): You have to put on a coat. If you put on shoes, the scarf you put on has to be striped.

Closet provides: striped scarf, green scarf, shoes, coat

The bear wears: coat

Whether or not such an outcome is deemed adherent to instructions depends on the environment, the theory, and the participant's access to presupposition-cancellation mechanisms. Let us first consider the antecedent environment, where there is consensus that the embedded presupposition gets inherited wholesale. Thus, a speaker

Figure 3-3: Outcome scene for a critical trial (same for both environments)



uttering (31) is presupposing that there will be a scarf that is put on. Recall from Chapter 2 about how participants might reason in this type of task. Upon hearing the presuppositional sentence in the instruction phase, participants make certain assumptions about what the instruction-giver is taking for granted, e.g., that there is a scarf that the bear puts on. Upon seeing that the bear has not actually put on a scarf, the options are: (i) to take the bear to have gone against the instruction-giver's expectations, thus deeming them non-adherent, or (ii) adjust the initial interpretation of the sentence, locally accommodating the presupposition and thus making the bear's dress-up instruction adherent. Results from Chapter 2 suggested that adults opt for option (ii). But if children are less able to do so due to their lack of access to local accommodation, then the child participant should take the outcome to be non-instruction-adherent, and point out that both the striped scarf and the coat should be given to the bear in order to fix the mistake.

For the consequent environment, the expectations differ depending on the theory. On the asymmetric view, what the critical instruction sentence in (32) presupposes is that scarf is contingent upon shoes. Since the bear does not put on shoes in the outcome either, no further adjustments are necessary — the bear can be seen

as adhering to instructions. On the symmetric view, the sentence on the whole presupposes that a scarf is put on in the final dress-up. The expectation, then, is similar to that in the antecedent condition. The bear should either be deemed non-adherent to the instructions, or the participant should adjust their interpretation of the sentence in a way that cancels the problematic presupposition. Again, if children struggle with applying local accommodation, then they might reject the outcome in (32) and require that the striped scarf and coat be put on as well, analogously to the Antecedent critical trials.

Each participant saw four critical trials in total. We also included presuppositional control trials with unambiguously non-adherent outcome, to ensure that children are able to perform in the task so long as they don't have to evaluate the outcome based on presupposed content. Environment (i.e., trigger position, Antecedent vs. Consequent) was a between-subject factor.

3.3.2 Data collection

Child participants were recruited via online advertisements. All data collection took place virtually via Zoom video-conferencing and was restricted to participants in the U.S. whose dominant language at home (> 80% of the time) is English. The choice of online testing for child participants was driven by various considerations, including COVID-related restrictions and a goal of having a more diverse and ecologically valid participant pool compared to lab populations. Parents/legal guardians of child participants were asked to complete an IRB-approved consent form prior to participation.

Forty-eight English-speaking children aged 4 to 6 participated; we set 4 as the lower-bound based on when the relevant types of complex sentences (Diessel 2004) and the existence presupposition of definite descriptions (Aravind 2018) are acquired. Participants received a digital certificate of completion upon finishing the study.

3.3.3 Results and analysis

We excluded trials on which the child's fix suggested non-understanding of the task, such as removing items relevant to the first part of the instruction, or giving extraneous items not mentioned in the instruction to the bear. We also excluded trials on which the experimenter uttered the instruction incorrectly, and trials in which the child was clearly not paying attention or was distracted by the parent, as noted by a coder based on video recordings of the test sessions.

Our primary dependent measure is the Yes-response rates. Children behaved as expected on the presuppositional control trials, saying Yes nearly 100% of time for the True trials and 0% for the False trials.

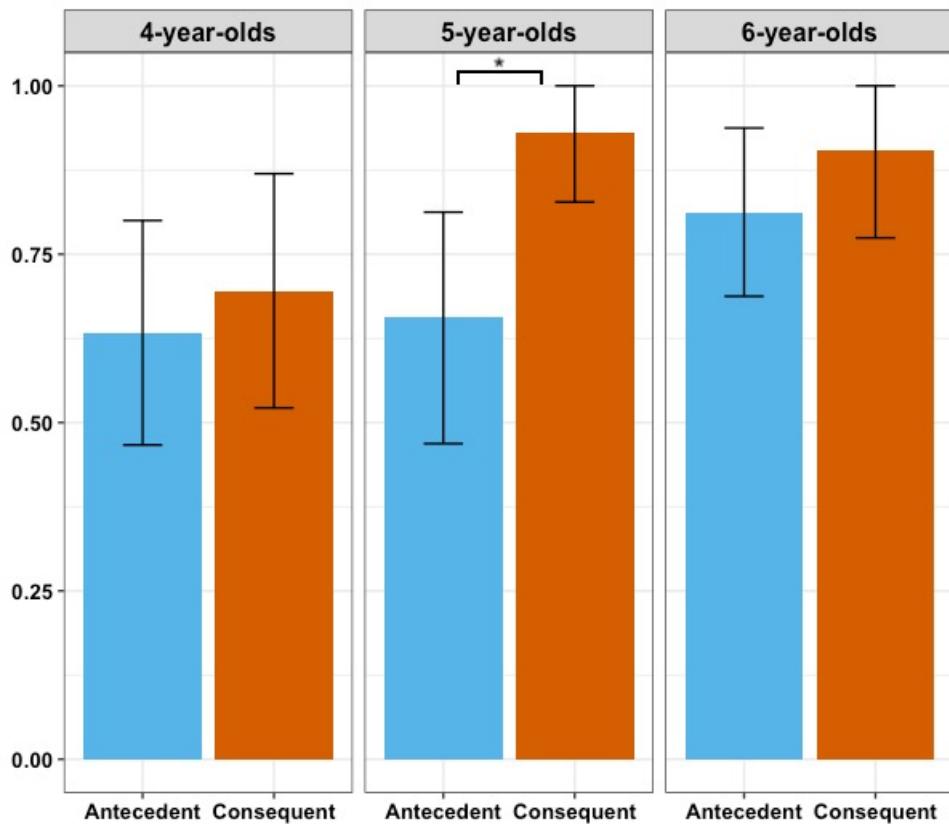
Table 3.1: Yes-response rates for control and critical trials

	Critical: Antecedent	Critical: Consequent	Presupposition Control: True	Presupposition Control: False
4-yos	63.33%	64.52%	96.67%	0%
5-yos	65.63%	93.10%	100%	0%
6-yos	81.25%	90.32%	100%	0%

For critical trials, we fit the data to a mixed-effects logistic regression model, with Environment and Age as fixed effects, and Participants and Items as random effects. We used the *glmer* function from the *lme4* package for R to compute the most maximally specified random-effect model that would converge, following Barr et al 2013). The model revealed main effects of Environment ($z = -2.036$, $p < .05$) and Age ($z = 2.819$, $p < .005$). Overall, children were less likely to evaluate an outcome as instruction-adherent when it failed to include the item described by an embedded presupposition in the Antecedent relatively to the Consequent, but their Yes-response rates increased across-the-board with age. Pairwise comparisons showed an asymmetry of Environment in 5-year-olds, with the consequent environment yielding significantly higher Yes-rates ($\chi^2 = 6.850$, $p < .01$). This is due to a subset of

5-year-olds who uniformly responded No in the Antecedent environment, but no 5-year-old participants responded this way in the Consequent environment. 6-year-olds reached high Yes-rates in both environments, with no statistically reliable difference between them ($\chi^2 = 0.447$, $p = .504$). Finally, 4-year-olds also showed no asymmetry between environments ($\chi^2 = 0.225$, $p = .635$), though with much lower but still above-chance Yes-rates ($z = 2.293$, $p < .05$), as shown in an intercept-only logistic mixed-effect regression model which included only the intercept as a fixed effect along with random intercepts for Participants and Items.

Figure 3-4: Yes-response rates per Environment per Age Group



As a secondary dependent measure, we also collected children's fixes after a No response. In the presuppositional control trials with an unsatisfactory outcome, for the Antecedent environment, children fixed the outcome by adding the item mentioned in the consequent of the *if*-conditional (in (33), a coat); for the Consequent

environment, the presupposed item (in (34), a scarf) was given in the wrong color, and children fixed the outcome by switching the green scarf with the striped scarf.

- (33) Presuppositional control (Antecedent): You have to put on shoes. If the scarf you put on is striped, you do have to put on a coat.

Closet provides: shoes, striped scarf, green scarf, coat

The bear wears: shoes, striped scarf

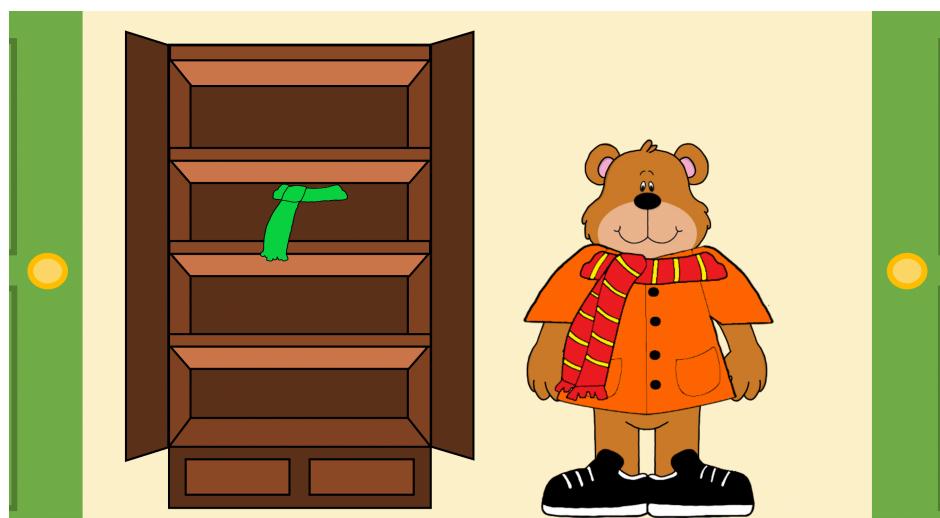
- (34) Presuppositional control (Consequent): You have to put on shoes. If you put on a coat, the scarf you put on has to be striped.

Closet provides: shoes, striped scarf, green scarf, coat

The bear wears: shoes, coat, green scarf

In the critical trials, where neither item mentioned in the *if*-conditional sentence was given, all children who responded No, including the subset of 5-year-old children (3 out of 8 in the Antecedent environment) who uniformly rejected the trials, fixed the scene by adding both mentioned items to the bear (Figure 3-5). This way of fixing the scene satisfies the requirements from the non-conditional presupposition as well as the entire conditional in the outcome.

Figure 3-5: Fixing performed for a critical trial



3.3.4 Discussion

3.3.4.1 Behavior by age group

Let us now consider our results by age group. First, the results from the outcome evaluation task revealed that 6-year-olds reached high Yes-rates in both environments, with only a numerical trend but no statistically significant asymmetry between the antecedent and the consequent. Perhaps on a first look, this result may seem surprising: on anyone's theory, presuppositions triggered in the antecedent of a conditional should end up being the presupposition of the sentence as a whole, but the dress-up outcome in the critical trials is not consistent with that. So why are the Yes-response rates so high in the antecedent environment for 6-year-olds?

Notice, first of all, that 6-year-olds' behavior is highly reminiscent of adults' response patterns in the experiments reported in Chapter 2: adults responded "Yes" in analogous situations. We suggest that 6-year-olds respond "Yes" for the same reason as adults did: because they have reached at a developmental stage where they *do* have access to local accommodation, facilitating a re-interpretation of the instruction in a manner that makes the outcome satisfactory. Local accommodation would generate a reading of the test sentence in the antecedent environment as in (35):

- (35) If there is a scarf that you put on and it is striped, you have to put on a coat.

Such a re-interpretation of the instruction in an outcome scene where no scarf was given can indeed allow the participants to consider the outcome instruction-adherent. Thus, 6-year-olds' behaviors indicate that at this stage, not only do they have an adult-like understanding of the presupposition projection rules of *if*-conditionals, but they are also adult-like in terms of their ability to apply local accommodation, possibly as a last resort mechanism, in order to avoid presupposition failure when this is a viable option. Such a finding is consistent with the results in Bill et al. (2016), who

reported that 7-year-olds endorsed local accommodation readings at a rate that, while numerically lower, was not statistically different from adults.

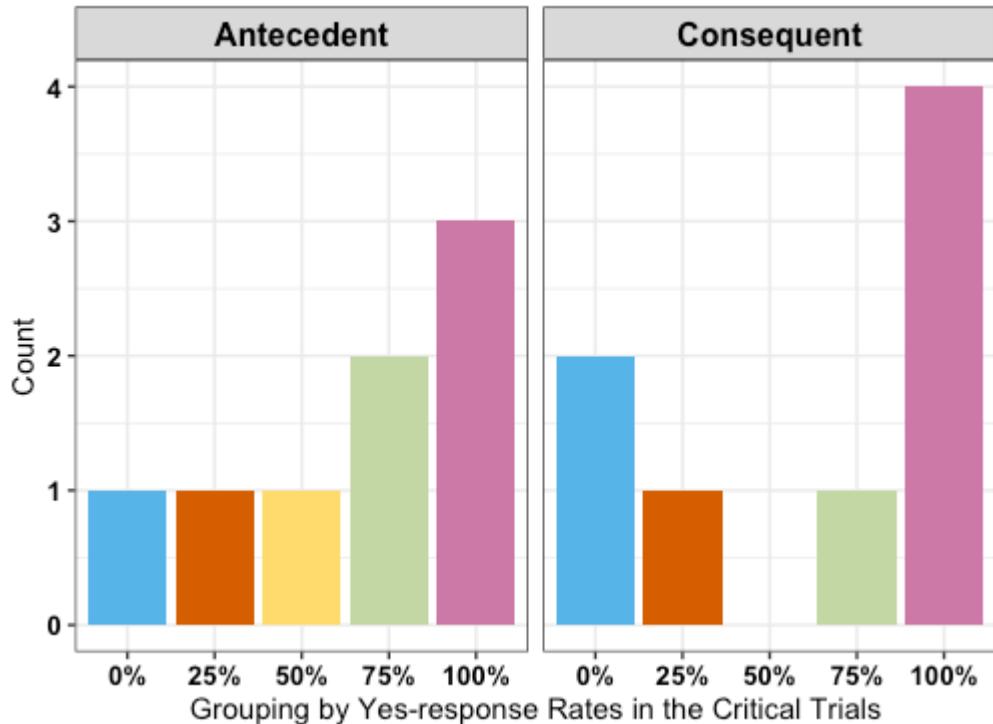
Meanwhile, the 5-year-olds' response pattern in our study revealed an environment-based asymmetry. While all 5-year-olds in the consequent environment overwhelmingly responded Yes to the critical trials, a subset of 5-year-olds in the antecedent environment uniformly rejected the outcome. One way of understanding this asymmetry is that this age group distinguishes presupposition projection from the antecedent and the consequent of *if*-conditionals in a manner predicted on the asymmetric view, but unlike 6-year-olds, have more difficulties accessing a local-accommodation reading. When the trigger is in the consequent and sentence presupposition is a conditional one, they can judge the outcome as instruction-adherent without further ado. However, when the trigger is in the antecedent, the outcome cannot straightforwardly be judged as satisfactory without revising one's initial interpretation of the instructions. Difficulties doing so (e.g., via local accommodation) results in some 5-year-olds rejecting the outcome scene in the experiment. This interpretation is consistent both with the adult results from Chapter 2, as well as previous developmental findings from Bill et al. (2016), who find that 4- and 5-year-olds have more difficulty with local accommodation compared to older children. Our results, as well as those reported in previous psycholinguistic work (Chemla & Bott 2013; Romoli & Schwarz 2015), show that accessing a local accommodation reading incurs a processing cost. Given children's more limited information processing capacity (Trueswell & Gleitman 2007), it is plausible that younger children (with the age of 5 being a reasonable proxy) who have not yet developed the processing capacity will struggle with this process.

If this interpretation of the child data is on the right track, it is most compatible with the asymmetric view of presupposition projection in *if*-conditionals. The asymmetric view takes the non-conditional presupposition *p* to be the basic semantic presupposition projected out of the antecedent but not the consequent environment.

Given the difficulty of applying local accommodation at least for some 5-year-olds, in our task, the asymmetric view predicts more “No” responses in the antecedent environment compared to the consequent.

Finally, the behavior of 4-year-olds remains a bit curious. Their Yes-rates in the critical trials are low (63.33% in Antecedent, 64.52% in Consequent). It is not the case that the 4-year-olds simply do not understand the task or the conditional sentences: their performance in the presuppositional controls are adult-like, suggesting that when the embedded presupposition is satisfied globally, they are able to evaluate an outcome against a conditional statement correctly. One may wonder if the 4-year-olds actually take a non-conditional presupposition to project from both environments (and struggle with local accommodation just like their 5-year-old counterparts). This possibility is rendered unlikely by the fact that 4-year-olds’ individual response patterns in the critical trials were variable, across both environments (Figure 3-6). This is in stark contrast to the 5-year-olds, who were consistent.

Figure 3-6: Non-uniform response patterns among the 4-year-olds



That the 4-year-olds' Yes-response rates are similarly low in both environments leave open many possibilities: it could be that they are somehow more sensitive to the pragmatics of conditionals, and show an overall dispreference for conditionals with false antecedents; it could be that they haven't developed a fully adult-like understanding of conditionals, and sometimes fall back on a conjunctive interpretation of conditional sentences, which is known to be a prominent misinterpretation among some young children (Evans & Over 2007; Oberauer et al 2007; Barrouillet & Lecas 1999; Lin 2020; Lecas & Barrouillet 1999); it could also be that these young children actually follow a different projection rule, which we have no further evidence for at the moment. Each of these possibilities will require more supporting evidence in order to be considered seriously, but at present, none of them provides a fully satisfactory explanation for the 4-year-olds' response patterns that we have observed. Finally, it could be that the 4-year-olds' behavior has to do with the particular ways our task interacts with the notion of global accommodation, which we spell out in the next section.

3.3.4.2 Issues with global accommodation?

One striking aspect of our results is the overall high "Yes" response rates. Even younger age groups, who, by hypothesis have less access to local accommodation, respond "Yes" to a dress-up outcome that lacks a scarf after instructions like (36).

- (36) If the scarf you put on is striped, you do have to put on a coat.

This behavior is unexpected if these children: (i) recognize what the instruction-giver is presupposing that a scarf is to be put on, (ii) recognize that the bear has not behaved in adherence with this presupposition, and (iii) does not have the machinery that would help them re-interpret the instruction sentence in a more charitable way.

But so far, we have only seriously considered two possibilities about how our task

relates to presuppositions and assumptions about the common ground. One is that the participants take the presupposed content (e.g., that a scarf is put on) to have been common ground between the instruction giver and receiver, and responds “No” when the bear has seemingly acted against what was previously taken for granted. The other is that the participant, after post-hoc adjustments, assumes that the presupposed content was never common ground and treats the utterance itself as ultimately presupposition-less (via local accommodation). There is another possibility, however, which we mentioned in passing in Chapter 2. Perhaps the participants do not assume it was common ground that a scarf will be put on in the outcome of the dress-up, but they treat the instruction-giver’s sentence as presupposing this. In such a situation, the expectation is that the instruction-receiver accommodates the presupposition and then, presumably, adheres to it.

This third possibility might not make distinct predictions from the first one for adults. After all, listeners are expected to (globally) accommodate a speakers’ presuppositions as need, and in the present context, where the speaker is themselves an authority figure, they may be all the more incentivized to do so. However, matters are not so straightforward in child language. Aravind (2018) showed that for children under the age of 6, global accommodation is less available globally. In a Listener Identification Task, participants had to identify the addressee of a presuppositional sentence. There were two choices: an overly informed listener who shared the presupposed information as well as the asserted information with the speaker vs. an under-informed listener who shared neither. Adults in this situation reliably chose the under-informed listener, under the assumption that such a listener could accommodate the presupposition, whereas the over-informed listener couldn’t “un-know” the asserted content to make the utterance non-redundant. 6-year-olds were adult-like. However, 4- and 5-year-olds chose at random, suggesting that they did not generate the expectation that the listener could accommodate an as-yet unmet presupposition.

On this interpretation, for younger children, pragmatic infelicity arises whenever the presuppositions of a sentence is not already clearly common ground prior to utterance.

This property of child grammar raises an alternative explanation for the high Yes-response rates. If children thought that the instruction-giver presupposed something that was not common ground at time of utterance, and furthermore, they don't expect that the bear should accommodate it, they may not see the bear's outcome as unsatisfactory. After all, the fault lies with the interlocutor. The idea is simple: everything is a good response to a bad set of instructions.

While this could explain the high "Yes" rates among the younger children, even in the antecedent condition, it is important to note that this cannot explain everything. We still have an environment-conditioned asymmetry in the rates of saying "Yes" with the 5-year-old ground. So ultimately, our overall conclusions remain.

3.4 Experiment 5: Acquisition of projection in disjunctions

Findings from Experiment 4 speaks in favor of the asymmetric view, but the effect is small and significant only in one age-group, limiting the force of our conclusions. We are currently working on a replication of the experiment with the goal of testing a total of 32 5-year-olds (i.e., doubling our sample size for this age group in the Experiment 4), which we hope will corroborate our current findings. Furthermore, as with the adult population, we also propose to extended our investigation to disjunctive sentences. If we find parallel asymmetries in children's behavior with disjunction, that would help bolster our interpretation of the results in Experiment 4.

At the same time, disjunctions introduce their own complications, both from a theoretical and a developmental perspective. First, the empirical and theoretical landscape of presupposition projection in disjunctions are controversial, and there

are disagreements about the right projection patterns, even among theorists who agree about projection in conditionals (see Chapter 2, Section 2.3 for discussions). Furthermore, children have been shown to behave in distinctly non-adult ways with disjunctions. For instance, some children access a *conjunctive* interpretation of *or*,¹ rejecting a disjunctive description “ ϕ or ψ ” in contexts in which only one of the disjuncts is true (Paris 1973; Braine & Rumain 1981; Chierchia et al. 2004; Singh et al. 2016; Tieu et al. 2017). The conjunctive interpretation of *or* may complicate our investigation into how presuppositions project out of disjunctions, given that disjunction and conjunction are known to have distinct projection properties. These issues will impact both our methodological choices (e.g., how our paradigm and materials should be adapted) and our interpretation of the results. I will now describe the design of the proposed experiment.

3.4.1 Design and materials

The overall setup and procedure of Experiment 5 will be identical to Experiment 4. An Outcome Evaluation Task will be presented to the child participant as a “dress-up” game, where a bear is instructed to put on a certain set of clothes. The child’s job, as before, is to tell the bear if she did a good job following instructions.

The experiment will begin with a training phase. There are 3 training trials in total, the first two of which have Yes as the expected response and the last one has No as the expected response. The child will receive feedback (with scaffolding if necessary) during the training phase. The goal of training is to make sure the child understood the basics of the task. In addition, the second training trial (as shown in (37), with the outcome in Figure 3-7) is created using a non-presuppositional disjunctive sentence, with the purpose of detecting conjunctive interpretations of *or*.

¹The source of the conjunctive interpretation is subject to debate (Skordos et al. 2020; Jasbi & Frank 2017; Sauerland & Yatsushiro 2018; a.o.).

(37) Training trial #2: You have put on a shirt, or you have to put on pants.

Closet provides: shirt, pants, shoes

The bear wears: pants

Figure 3-7: Outcome scene for the non-presuppositional disjunction training trial



In (37), the outcome scene shows that only one of the mentioned items is given to the bear, thereby satisfying the requirements of the instruction (Figure 3-7). If the child responds “No”, rejecting the outcome and attempting to fix it by adding the shirt to the bear, that would correspond to a conjunctive interpretation. These children will receive explicit feedback on the interpretation of disjunction, and will be excluded if they continue with a conjunctive interpretation throughout the task.

As before, our critical trials are intended to detect how presuppositions project from the two arguments of *or*. The presupposed item, a scarf, does not appear in the outcome of the bear’s dress-up (Figure 3-8). The expectations are similar to those for *if*-conditionals. If the presupposition trigger is contained within the 1st Disjunct, as in (38), the absence of a scarf in the outcome should render it unsatisfactory relative to the instructions unless one locally accommodates the presupposition. This is the case on either theory.

- (38) Critical trial (1st Disjunct): The scarf you put on has to be striped, or you have to put on a coat.

Closet provides: striped scarf, green scarf, shoes, coat

The bear wears: coat

Figure 3-8: Outcome scene for a critical trial (same for both environments)



- If the trigger is in the 2nd Disjunct, as in (39), the expectations vary by theory. On the asymmetric view, (39) presupposes that a scarf has to be put on if a coat is *not* put on. The bear's dress-up conforms to this presupposition. On the symmetric view, (39) presupposes that a scarf has to be put on — non-conditionally. The bear's dress-up should not be judged as adherent to the instructions in that case (modulo local accommodation).

- (39) Critical trial (2nd Disjunct): You have to put on a coat, or the scarf you put on has to be striped.

Closet provides: striped scarf, green scarf, shoes, coat

The bear wears: coat

Each participant will see 4 critical trials in total. We will also include presuppositional control trials with unambiguously (un)satisfactory outcome, to ensure that children

are able to evaluate the truth/falsity of presuppositional disjunctive statements in contexts where the presupposition is satisfied across-the-board. Environment (i.e., trigger position, 1st Disjunct vs. 2nd Disjunct) is a between-subject factor.

In addition, we will include two **conjunctive control** trials. The conjunctive controls are such that there is a presupposition trigger embedded either in the 1st or the 2nd conjunct, and only the presupposed item (in (40), the yellow coat) is put on by the bear:

- (40) Conjunctive control: The coat you put on has to be yellow, AND you have to put on some shoes.

Closet provides: yellow coat, orange coat, scarf, shoes

The bear wears: yellow coat

Figure 3-9: Outcome scene for a conjunctive control



The child is expected to respond No to the outcome scene in Figure 3-9. These conjunctive controls will serve the purpose of ensuring that children understand the task and the sentences, and that they are paying attention to the particular connective being used in the experiment. Only children who respond correctly to both conjunctive controls will be included in analysis, to make sure that our results are

not amenable alternative explanations, such as children simply doing a lexical-item check to see if (only) one of the mentioned items is given.

3.4.2 A note on our linguistic materials

As was our previous experiment involving conditionals, the present experiment involving disjunctions will also be presented in an *instruction* mode. As such, the disjunctive sentences take the following forms:

- (41) a. The scarf you put on has to be striped, or you have to put on a coat.
b. You have to put on a coat, or the scarf you put on has to be striped.

This differs from the adult experiment, in which we used modal-less disjunctive sentences presented in a *prediction* mode. The main reason for this difference is a practical one: through several pilot studies, we found that children were having great difficulty understanding the prediction task, showing more confusion and a higher error rate in the controls. Since we did not encounter such an issue in the conditional experiment, we propose to switch back to the instruction mode and adjust the materials for disjunctions accordingly.

A concern that this change raises is that the disjunctive sentences we will be using take a more complicated form, as they now include the modal “have to” in each disjunct. How are the sentences interpreted in our task? Let’s consider (42) as an example, which takes the same form as our test sentences, i.e., a disjunctive sentence with two occurrences of “have to”:

- (42) To pass the exam, you have to read Book A or you have to read Book B.

There are two possible interpretations, depending on the scopal relation between the modal and disjunction. Under the interpretation that the modal scopes over

disjunction (*have to* >> *or*), there are worlds where you have to read Book A and pass the exam, and there are worlds where you have to read Book B and pass the exam, but there are no worlds where you don't read either book yet still pass the exam. So more concretely, I can choose to read only Book A and I will pass the exam; I can read only Book B and I will also pass the exam. Either option will work for me.

Another interpretation of (42) is one in which disjunction scopes over the modal (*or* >> *have to*): To pass the exam you have to read A, or to pass the exam you have to read B. But we don't know which book is the one that will help you pass. So if I read Book A and my classmate reads B, only one of us will have a chance at passing the exam; it is possible that I unfortunately end up reading the wrong book and fail.

The presupposition-less version of our test sentences takes the form of “you have to put on a coat, or you have to put on a scarf”. In our task, the only sensible interpretation of such sentences is *have to* >> *or*, with the modal scoping over disjunction, because the alternative *or* >> *have to* interpretation will be pragmatically odd due to the ignorance inference associated with it: the experimenter who delivers the sentences as instructions is fully aware of the satisfying conditions.

How about presupposition projection? For a sentence like “The dress you put on has to be blue, or you have to put on a coat”, the presupposition embedded inside the 1st disjunct is “there is a dress you put on”. The different scope options do not actually affect projection: if we assume that $(\phi_p \text{ or } \psi)$ presupposes p , and $(\text{have to } \phi_p)$ presupposes p (assuming universal projection out of the deontic modal), then the projection result does not differ across the two scopal options. Thus, moving forward, we will assume the *have to* >> *or* interpretation for the disjunctive sentences used in our task.

3.4.3 Discussion

Because of time constraints, there is no data to report at the moment. It might still be useful to consider what sort of outcomes that could be consistent with the asymmetric view. Below, I sketch two such possible outcomes.

One possible outcome that would be compatible with the asymmetric view is, of course, an asymmetry in “Yes” response rates (at least with 5-year-olds, in light of our findings from Experiment 4). Specifically, they might reject an outcome that e.g. is missing a scarf if the presupposition trigger, “the scarf you put on” was inside the 1st Disjunct compared to the 2nd Disjunct. In other words, the overall pattern might be similar to what we observed for *if*-conditionals, with an environment-based asymmetry. If such a result obtains, this will be a straightforward addition to the evidence adduced so far in favor of the asymmetric view.

Another possibility is symmetry. Children might uniformly accept a “scarfless” outcome, irrespective of which disjunct the trigger “the scarf that you put on” appears. Such an outcome, first of all, would be incompatible with symmetric theories, as they predict uniform “No” responses. At the same time, this outcome would not be compatible with certain types of asymmetric theories either. In particular, neither the Middle Kleene logic nor Satisfaction Theory predicts this.

Nonetheless, once we consider the child data for conditionals and disjunctions collectively, a plausible explanation arises that will also be compatible with our processing results: an incrementalized version of the Strong Kleene logic, which is another candidate from the asymmetric theories. The Strong Kleene logic (see Chapter 1, Section 1.2.2), agrees with Middle Kleene and Satisfaction Theory in predicting the weaker, conditionalized presupposition from the right argument of both *if* and *or*. The crucial point of divergence is that for *or*, the Strong Kleene logic by itself derives a symmetric pattern of projection. On this view, a disjunction is true if at least one of the disjuncts is true, false if both disjuncts are false, and it is undefined (#) otherwise.

wise. Thus, a disjunction on the whole can be true *even if* either one of the disjuncts, 1st or 2nd, receives $\#$. The fact that the “felt” presupposition of the 1st disjunction is stronger arises from the fact that we process sentences left-to-right, incrementally. Thus, this second possible outcome would be compatible with this theory of presupposition projection, if one makes the auxiliary assumption that children’s processing abilities or capacities are not yet fully developed compared to the adults, and thus such incremental processing bias may not be nearly as prominent in child language data.

3.5 Summary and outlook

In this chapter, we presented novel evidence about preschool-aged children’s understanding of presuppositional conditionals. We found an environment-based asymmetry in 5-year-olds’ expectations about what conditionals presuppose. Such a finding, together with our processing results from Chapter 4, provide further evidence in favor of an asymmetric view of presupposition projection from the developmental perspective.

We also suggested ways of extending the investigation to disjunctions and offered some speculations about what data patterns might be amenable to an asymmetric view of projection. Among these two possibilities, the second possible outcome, perhaps counter-intuitively, involves finding a symmetry, with “Yes” response rates being high for both disjuncts. If such an outcome is obtained, we may try to reconcile it with the findings of asymmetry in the processing of disjunction (Chapter 2) by appealing to the Strong Kleene logic. We hope that a systematic investigation of presupposition projection in child language data across conditionals and disjunctions will help shed further light on the underlyingly projection pattern, and potentially tease apart whether asymmetries in disjunction is semantically derived or as the result of an

incremental processing bias.

Chapter 4

Pragmatic Strengthening and Discourse Structure

4.1 Challenge to Pragmatic Strengthening

The goal of the previous chapters was to disentangle the “basic” semantic presupposition projected out of *if*-conditionals and disjunctions from additional processes. Results from a series of behavioral experiments, from both adults and children, seem to favor an asymmetric view of presupposition projection, which derives a weak, conditionalized presupposition for the right argument of binary connectives. At the same time, we have not yet addressed the Proviso Problem (Geurts 1996): the fact that the felt presupposition in this environment is sometimes stronger than what is predicted under the asymmetric theories. We see this in (43), where the felt presupposition is stronger than what is predicted.

- (43) If Phil is traveling to London, he will bring his guitar on the trip.

Presupposes: Phil has a guitar.

Defenders of the asymmetric theories commonly argue that this does not neces-

sarily constitute an issue for the theoretical predictions of “semantic presupposition”, once we supplement the asymmetric theories with a mechanism of pragmatic strengthening. In a nutshell, there are systematic, pragmatic considerations that will help us make sense of why a speaker is felt to take for granted more than the sentence’s semantic presupposition, such that the semantic presupposition of *If* ϕ , ψ_p (like (43)) may be strengthened from the conditional one *If* ϕ , p to the non-conditional p (Karttunen & Peters 1979; Soames 1982; Heim 1990, 1992; Beaver 1992, 1999, 2001; Heim 2006; van Rooij 2007; Singh 2007, 2008; von Fintel 2008; Pérez Carballo 2008; Fox 2008, 2013; Schlenker 2011, Lassiter 2012; Lauer 2015; Sudo 2014).

However, a serious challenge has been raised by Mandelkern (2016a, 2016b), which potentially undermines the asymmetric theories. The data Mandelkern presents involve situations where a non-conditional presupposition obtains, even though it is patently infelicitous. This is hard to explain if the non-conditional presuppositions are (always) the result of strengthening based on plausibility and other pragmatic considerations. In this chapter, I re-examine the Mandelkern data. I will pursue an idea that can be further developed for the asymmetric theorists to address the challenge: that the perceived non-conditional presupposition is not triggered by the conditional assertion, but an accommodated question in the relevant scenarios. While I believe that the direction is promising, I will note at the outset that it is provisional in nature.

The chapter is organized as follows. In the remainder of this section, I will discuss two popular ways of implementing the pragmatic strengthening mechanism,¹ and review how Mandelkern’s data present a challenge for both of them. Then, in Section 2, I will build on a generalization first noted in Fox (2019), and discuss how this insight may be further developed into a better understanding of the Mandelkern data by taking into account what question is being made salient in the discourse. This

¹My discussion will focus on *if*-conditionals, but these accounts easily generalize to conjunctions and disjunctions.

non-conditional presupposition is not obtained via pragmatic strengthening, and thus standard considerations for strengthening are simply irrelevant. Section 3 provides a response to Mandelkern’s dismissal of a pragmatic response along the lines of what is being explored here. Finally, Section 4 discusses the implications of the present work for theories of presupposition projection.

4.1.1 Pragmatic strengthening mechanisms

4.1.1.1 Plausibility-based strengthening

A plausibility-based view of strengthening² can be synthesized as follows:

- (44) PLAUSIBILITY-BASED STRENGTHENING: Conditionals that take the form of *If* ϕ , ψ_p semantically presuppose *If* ϕ , p . When a speaker utters *If* ϕ , ψ_p , in a context that doesn’t entail the semantic presupposition, the listener who must decide what to accommodate compares the relative plausibility of:
- a. The speaker presupposes just *If* ϕ , p ;
 - b. The speaker presupposes p .

The listener concludes the latter options, p , if they have pragmatic reasons to think that it is more plausible.

Under this view, the previous example that we saw before, repeated in (45), still has the conditional presupposition as its semantic presupposition, as derived by the asymmetric theories:

- (45) If Phil is traveling to London, he will bring his guitar on the trip.
- a. *If Phil is traveling to London, he has a guitar.*
 - b. *Phil has a guitar.*

²Versions of this view can be found in Karttunen & Peters (1979), Soames (1982), Heim (1990, 1992), Beaver (1992, 1999, 2001), Heim (2006), Singh (2007, 2008), von Fintel (2008), Fox (2008), Lauer (2015), Sudo (2014), among others.

But when reasoning about what the speaker of (45) is presupposing, the listener compares the plausibility that the speaker takes (45-a) for granted *versus* (45-b). They do have a pragmatic reason to think that it is more plausible that the speaker is presupposing (45-b): (45-a) is a pretty odd conditional given our world knowledge, and so it is difficult to see why a speaker would only take that for granted. On general grounds, then, the listener reasons that it is plausible that if a speaker is assuming *If* ϕ , p , it is because they are also assuming something stronger which entails it — Phil has a guitar. This leads the conclusion of the strengthened presupposition in (45-b).

By contrast, in (46), strengthening does not apply. When a speaker utters (46), the listener compares (46-a) and (46-b) as candidates for what the speaker is taking for granted:

(46) If Phil is a musician, he will bring his guitar to the party.

- a. *If Phil is a musician, he has a guitar.*
- b. *Phil has a guitar.*

There is no pragmatic reason for the listener to think that it is more plausible for the speaker to take for granted (46-b). As such, the semantic presupposition (46-a) surfaces as what the speaker is felt to presuppose.

4.1.1.2 Independence-based strengthening

An independence-based view of strengthening³ can be found in several authors' work (van Rooij 2007; Pérez Carballo 2008; Schlenker 2011; Lassiter 2012; cf. Mandelkern & Rothschild 2019). Though these authors subscribe to somewhat different notions

³Note that the independence-based view is not necessarily incompatible with the plausibility-based view; it can be seen as an elaboration of the latter, e.g., it is the independence relation between ϕ and p that created the oddness of the conditional presupposition. That being said, some authors have defended the independence-based view without committing to the plausibility-based view (see Pérez Carballo 2008 and Lassiter 2012), and thus I follow Mandelkern in offering a separate discussion of it.

of independence, here I will take Lassiter (2012) as an example, who adopts a probabilistic view of independence.

Lassiter takes presuppositions to be conditions on conversational participants' probabilistic epistemic states, and presupposed information is taken for granted. The probabilistic notion of independence is defined such that learning about the probability or truth-value of ϕ will not affect the estimated probability of p , i.e., $\text{pr}(p) = \text{pr}(p|\phi)$. As a concrete example, the key difference between (47-a) and (47-b) lies precisely in the independence relation between ϕ and p : in (47-a), ϕ and p are *not* independent because learning about Phil being a musician likely increases our estimation of the probability that he owns a guitar; in (47-b), however, ϕ and p are probabilistically independent, because learning about Phil's upcoming trip to London doesn't impact our estimated probability of his ownership of a guitar:

- (47) a. If Phil is a musician, he will bring his guitar to the party.
- b. If Phil is going to London, he will bring his guitar on the trip.

Crucially, it is inappropriate to take something for granted unless it is *highly probable*, represented by a threshold θ . To decide whether p can be taken for granted is to judge whether the information favoring p is sufficiently strong, i.e., whether its probability equals or exceeds θ .

Given this notion of independence, the key insight of independence-based strengthening can be synthesized as follows:

- (48) INDEPENDENCE-BASED STRENGTHENING: Conditionals that take the form of *If* ϕ, ψ_p semantically presuppose *If* ϕ, p . When a speaker utters *If* ϕ, ψ_p , if ϕ is (assumed to be) independent of p , then the speaker is felt to presuppose p ; otherwise, they are felt to presuppose just *If* ϕ, p .

In the case of (47-b), the speaker believes that, given the information “Phil is

going to London”, the probability of “Phil owns a guitar” is sufficiently high (49-a). Since these two propositions are independent (49-b), the probability of “Phil owns a guitar” should be just as high (49-c). Thus, the non-conditional presupposition p is treated as information that can be taken for granted.

- (49) a. $\Pr(p|\phi) \geq \theta$
- b. $\Pr(p) = \Pr(p|\phi)$
- c. THEREFORE: $\Pr(p) \geq \theta$

By contrast, it will be inappropriate to assume an independence relation between “Phil is a musician” and “Phil owns a guitar”, given our world knowledge: learning whether Phil is a musician will typically influence the estimated probability that he owns a guitar. As such, we cannot draw any conclusions about the probability of p with respects to θ , and consequently there is no sufficiently strong information to indicate that p can be taken for granted; only the conditional presupposition *If* ϕ , p obtains.

4.1.2 A Challenge from Mandelkern (2016a, 2016b)

Mandelkern (2016a, 2016b) presents data that challenges the standard theories of pragmatic strengthening, all of which has the property of what he calls “unexpected strengthening”. These cases involve sentences that appear to give rise to a non-conditional presupposition, when pragmatic strengthening is expected to be *not* available. The key data have the general feature of involving an infelicitous or peculiar continuation of a presuppositional conditional sentence, in a context where the speaker is felt to presuppose something that is not on the common ground. Let us take a look at (50), which is the leading example in Mandelkern (2016b):

- (50) SMITH’S MURDER

[It is common ground that Smith has gone missing, and we don't know whether he is still alive.] A detective enters and says: ??“If the butler's clothes contain traces of Smith's blood, then it was the butler who killed Smith/we will soon have Smith's murderer behind bars.”

- a. *If the butler's clothes contain traces of Smith's blood, someone killed Smith.*
- b. *Someone killed Smith. [felt presupposition]*

According to Mandelkern, intuitively the detective in the above context is felt to presuppose (50-b), rather than (50-a), as confirmed by the ‘Hey wait a minute’ (HWAM) test:

- (51) Hey wait a minute! I didn't know someone killed Smith!

This is a felicitous response to (50), and is taken to suggest that the speaker in (50) is felt to commit to (50-b). But this is peculiar: the context is such that we don't know whether Smith is still alive, so assuming that the speaker is rational and cooperative, it should not have been taken for granted that Smith has been murdered. The conditional presupposition as stated in (50-a), on the other hand, seems to be a plausible hypothesis to be attributed to the detective in this situation. So there appears to be no pragmatic reason to select (50-b) over (50-a) on the plausibility view of strengthening. As for the independence view of strengthening, in the conditional presupposition, the antecedent “the butler's clothes contain traces of Smith's blood” and the embedded presupposition “someone killed Smith” are not independent from each other in any obvious sense: learning about the butler's clothes containing traces of Smith's blood certainly increases our estimated probability of Smith's death, given common sense. Thus, whichever notion of strengthening we adopt, it seems that in this example, pragmatic strengthening should not be available. So why do we feel

that the speaker is presupposing (50-b), when in fact there seems to be pragmatic pressure from the context against it?

To show the generality of the problem across different triggers, let me go over two more examples here from (2016a, 2016b).⁴

(52) DIABETES UNDER CONTROL

Is John in good health? Is he taking care of himself?

[I'm not sure, but we should be able to tell at dinner;] ??if he's restricting his sugar intake, then his diabetes is under control.

- a. *If John is restricting his sugar intake, he has diabetes.*
- b. *John has diabetes. [felt presupposition]*

In (52), the context is such that the speaker of the conditional assertion does not know whether John is in good health, but they are felt to presuppose (52-b), hence the oddity of the response. There is no obvious reason why (52-a) shouldn't be the natural plausible assumption that the speaker entertains instead, nor is there any indication that the antecedent “John is restricting his sugar intake” is somehow independent from “John has diabetes”. Yet the non-conditional presupposition in (51-b) seems to be the one that obtains, contrary to the prediction of pragmatic strengthening.⁵

⁴There are two additional examples that I'm leaving out here, one concerning “waterproof coats” and the other “broken windows”, partly for space reasons and partly because I think they are weaker examples to make Mandelkern's point anyways.

⁵Mayr & Romoli (2016) proposed an account that treats the two possible presuppositions of *If* ϕ , ψ_p (and ϕ or ψ_p) as a matter of systematic, truth-conditional ambiguity, and ties the bi-conditional reading of *if*-conditional to presupposition strengthening in the consequent environment. As it stands, their account amounts to saying all (presuppositional) conditionals *can* in principle have a bi-conditional reading. This is, however, at odds with what we know about conditional strengthening from von Fintel (2001): true conditional perfection (*If and only if* ϕ , ψ) doesn't in fact routinely arise; it does only when the conditional statement is being asserted as an answer to a question that elicits *an exhaustive list of sufficient conditions for the consequent*. This problematizes Mayr & Romoli's (2016) suggestion (in their foot 12) that their account can be developed into an explanation for Mandelkern's examples: for the Diabetes Under Control example, they suggest that the conditional utterance strongly favors or can only receive the bi-conditional reading, in order to explain the obligatoriness of the strengthened presupposition. But this does not seem correct. The conditional

One more example in (53), taken from Mandelkern (2016a):

(53) CROSS-COUNTRY RUNNER

John was limping earlier; I don't know why. Maybe he has a stress fracture. I don't know if he plays any sports, ??but if he has a stress fracture, then he'll stop running cross-country now.

- a. *If John has a stress fracture, John has been running cross-country.*⁶
- b. *John has been running cross-country. [felt presupposition]*

The discourse strikes us as quite strange, because the speaker just said they didn't know if John plays any sports, yet their utterance seems to indicate that they take (53-b) — that John has been running cross-country — for granted. Again, there is no clear reason to assume any independence between the antecedent “John has a stress fracture” and the embedded presupposition “John has been running cross-country”, and no reason for (53-a) to be rejected for being “a strange conditional” for the speaker to take for granted. Yet it appears to be strengthened to (53-b), rather unexpectedly. Mandelkern argues that it is difficult to see how “broadly pragmatic considerations help explain this strengthening.”

These cases of “unexpected strengthening” present a challenge for the notions of pragmatic strengthening as described in the previous sections: the non-conditional presupposition in (b) in each of these examples is not expected to arise under standard considerations that will induce strengthening, yet somehow in these context, it is as if presupposing the non-conditional *p* is **obligatory**. Based on these data, Mandelkern

utterance in the example does not satisfy the condition that von Fintel (2001) puts forward: surely there are other ways of finding out about John's health condition, which can be brought up and discussed, and the speakers and listeners are not under any circumstances to assume otherwise. The bi-conditional reading does not appear to be a salient one, let alone being the only reading available.

⁶In Mandelkern (2016a), the presupposition here was described as “John once ran cross-country”. This is incorrect: for the sentence “he will stop running cross-country”, the presupposition projected from the trigger *stop* is “he has been running cross-country”, not that he used to or he once did. I will be using my description from here onward. Thank you to Kai von Fintel for pointing this out to me.

concludes that both plausibility-based and independence-based notions of pragmatic strengthening are problematic. He further argues that, since pragmatic strengthening is an indispensable component of the asymmetric theories (in order to solve the proviso problem), it must be that those theories are *not* sustainable, and thus should be rejected in favor of an alternative theory that derives *p* as the semantic presupposition projected out of the consequent of *if*-conditionals.

The data raised in Mandelkern (2016a, 2016b) indeed presents a challenge for the asymmetric view. In response to this, Fox (2019) provided fresh perspectives on the matter, which I turn to next to guide my subsequent discussions.

4.2 Accommodating questions: Toward developing a new explanation

4.2.1 Fox's generalization

Fox (2019) offers a different perspective on the Mandelkern examples, and provides some contrasting examples in which the non-conditional presupposition does not appear to arise, once we manipulate the discourse context. Let me first present their contrasting examples below side by side for comparison:

- (54) SMITH'S MURDER (Mandelkern)

[It is common ground that Smith has gone missing, and we don't know whether he is still alive.] A detective enters and says: ??“If the butler's clothes contain traces of Smith's blood, then it was the butler who killed Smith/we will soon have Smith's murderer behind bars.”

- (55) SUSIE'S MURDER (Fox)

[Susie has disappeared. The detective and her team have been working non-

stop for 48 hours. The detective says:] “We still weren’t able to figure out whether her kidnappers have her or whether she was murdered early this morning. **But we did figure out where she was kept last night.** If there are signs of mass bleeding, **we will take the rest of the day off** and begin our attempts at identifying the murderer early tomorrow morning. If there aren’t, *we meet here at 2PM*, working under the assumption that Susie is still alive.”

In (55), unlike the Mandelkern example in (54), we do not feel that the detective is committed to a murder having taken place. In both, the context makes it clear that we actually don’t know if a murder has happened. What characterizes these pairs is that (i) we have kept the presuppositional sentences; (ii) yet there is a contrast in the nature of the presupposition, obtained from a manipulation of the discourse context. This, in turn, raises the possibility that the non-conditional presupposition is not in fact obtained from strengthening of the conditional presupposition itself, but from third factors introduced in the discourse context.

Fox (2019) points out that the key difference between (54) and (55) lies in what question is being made salient in the relevant context, which then affects how the hearer reasons about what common ground the speaker must have in mind. In the case of (54), the most salient question is (how do we find out) whether Smith was murdered, which is addressed by the presuppositional conditional. This leads to markedness or infelicity typically found in discourses in which a question is being addressed by an accommodated presupposition.⁷ But in the case of (55), the context makes a different question salient, “what should *we* do (under various circumstances)”, such that it no longer faces the same problem. If this is indeed on the right track, then Mandelkern’s argument to abandon the asymmetric theories is weakened. It

⁷An idea that Irene Heim suggested to Mandelkern, which he dismisses; I will return to this in Section 3.

further suggests that there must be some other reasons — likely related to how a context makes one question salient rather than another — which ultimately lead to the hearer inferring that the speaker must be taking p for granted.

In what follows, I elaborate on this generalization, and suggest a possible direction to understand the Mandelkern examples that crucially builds on Fox's (2019) insight. The crux of the idea is that the perceived non-conditional presupposition in these cases is not triggered by the conditional assertion itself, but comes from an accommodated question in the relevant scenarios, and thus these data do not necessarily present a threat to the notion of pragmatic strengthening.

4.2.2 More on salient questions in the context

To elaborate on Fox's (2019) generalization, in each of the Mandelkern examples mentioned earlier (summarized in Table 4.1), the antecedents express a possible observation we may make, or a piece of evidence we may find, such as discovering traces of blood or learning about John's certain health condition. These possibilities are raised in a context where the relevant facts are *not* yet established, and there is a salient question under discussion about them, e.g., *Is Smith dead?*, *Is John healthy?*. The embedded presuppositions of these conditional utterances express something along the following: if the antecedent turns out to be true, then what can we infer as an answer for the salient question in the context? This relates to why we raise the possibility expressed in the respective antecedent: if we find traces of Smith blood on Butler's clothes, this gives us some reason to infer that the answer to the question of what happened to Smith is that he had been murdered; if we find out at dinner that John is restricting sugar intake, then we may use this observation to infer that John does have some health conditions, which we are wondering about, and in particular he has diabetes; if John's limping turns out to be because he is suffering from a stress fracture, then it is likely that he has been engaging in sports, which cross-country

running is a kind of.

Table 4.1: Salient questions in the examples: ψ addresses the question, in case of ϕ

Ex	Salient question	ϕ : What might we find?	p in ψ : Given the observation, what can we infer as an answer?
50	Is Smith dead?	Traces of Smith's blood on Butler's clothes.	Smith was dead.
52	Is John healthy?	John is restricting sugar intake.	John has diabetes.
53	Does John play sports?	John has a stress fracture	John has been running cross-country.

These Mandelkern examples as summarized in the table above differ from the more “classic” examples, which are typically presented in a “null” or out-of-the-blue context. Four examples of the latter kind are provided below for comparison. In these examples, there are *no* independence or plausibility-related factors that might trigger pragmatic strengthening. In line with the asymmetric theories’ prediction, the conditional presupposition is what obtains in each of the following cases:

- (56) If John is a scuba diver, he will bring his wetsuit on vacation. (Geurts 1996)

- a. *If John is a scuba diver, he has a wetsuit.* [**felt presupposition**]
- b. *John has a wetsuit.*

- (57) If Sam is a musician, he will bring his guitar to the party.

- a. *If Sam is a musician, he has a guitar.* [**felt presupposition**]
- b. *Sam has a guitar.*

- (58) If Sue is Catholic, she will read her Bible.

- a. *If Sue is a Catholic, she has a Bible.* [**felt presupposition**]
- b. *Sue has a Bible.*

- (59) If spaceman Spiff lands on Planet X, he will notice that he weighs more than on earth. (Beaver 1999)

- a. *If Spiff lands on X, he will weigh more than on earth. [felt presupposition]*
- b. *Spiff will weight more than on earth.*

In the conditional presuppositions expressed in (a) above, the antecedent raises a possibility about what we may find, and the consequent expresses what we can infer that will *follow* from the truth of the antecedent (summarized in Table 4.2). If John turns out to be a scuba diver, then he likely possesses the property that many (or most?) scuba divers share, based on which we may infer his ownership of a wetsuit; similarly, if Sam is a musician, an ampliative inference that follows from it is that he may possess a guitar, a perhaps somewhat common property of musicians. But lacking any preceding context, these conditional presuppositions do not appear to be providing an answer for some specific unsettled issue in a given situation — there simply isn't any explicit context provided, and thus no salient question of any kind waiting to be addressed or settled. There is only “the Big Question”: What are the ways things are?

Table 4.2: No salient questions in the classic examples: ψ is what follows from ϕ

Example	ϕ : What might we find?	ψ : What can we infer based on A? What <i>follows</i> from A?
56	John is a scuba diver	John has a wetsuit.
57	Sam is a musician	Sam has a guitar.
58	Sue is Catholic.	Sue has a Bible.
59	Spiff lands on Planet X.	Spiff weighs more than on earth.

Thus, following Fox (2019), I take it that the Mandelkern-style examples are characterized by there being a salient question in the context, which the non-conditional presupposition p serves to provide an answer to. But Mandelkern is correct in pointing out that we should not expect the non-conditional presupposition to be selected

if this is a matter of pragmatic strengthening, since the conditional utterances are infelicitous and the speaker should not take p for granted. So where does the non-conditional presupposition come from?

To fully understand the kind of role that discourse context is playing, and how it interacts with presupposition projection, I suggest that we focus on the following three minimally contrasting examples. In (60), the proposition p “Sam is a musician” is part of the asserted content of the consequent clause; nothing is being presupposed here:

- (60) [We don’t know what Sam does for a living. He could be a musician, a teacher, or a painter. We are hoping to find out more about him at a party.]
If Sam brings a guitar to the party, he is a musician and he is proud of being one.

By contrast, (61) is a Mandelkern-style example, which is infelicitous and gives rise to a non-conditional presupposition p , against a context where the relevant facts about p are not yet established.

- (61) [We don’t know what Sam does for a living. He could be a musician, a teacher, or a painter. We are hoping to find out more about him at a party.]
??If Sam brings a guitar to the party, he is proud of being a musician.
a. *If Sam brings a guitar to the party, he is a musician.*
b. *Sam is a musician. [felt presupposition]*

Finally, we are also interested in (62), which sharply contrasts with (61) in that a near-identical presuppositional conditional is uttered, but only a conditional presupposition seems to be available this time. This is roughly the same type of manipulation found in Fox (2019), but (62) is more of a minimal pair to the other examples being compared: The only thing that changed from (61) to (62) is the addition of the

sentence, *We also don't know how he feels about whatever it is that he does.*, in the context.

- (62) [We don't know what Sam does for a living. He could be a musician, a teacher, or a painter. We also don't know how he feels about whatever it is that he does. But let me tell you a few things:]

If he comes with a guitar, he is proud of being musician. (If he comes with a ruler in hand, he is a very funny teacher.)

- a. *If Sam brings a guitar to the party, he is a musician. [felt presupposition]*
- b. *Sam is a musician.*

A schematic summary of these contrasts is given in Table 4.3:

Table 4.3: Key contrast

Example	Key Property	Presupposition?
60	<i>If</i> ϕ , p and ψ	/
61	Mandelkern-style, <i>If</i> ϕ , ψ_p	p , “unexpected strengthening”
62	Minimally modified context, <i>If</i> ϕ , ψ_p	<i>If</i> ϕ , p

4.2.3 Complete Answer and Question Accommodation

My discussion of the discourses in Table 4.3 makes reference to a “salient question” raised by the discourse in context. This notion roughly corresponds to what is known as “Question under Discussion”, within the QUD theory of information structure which treats discourse as being “organized around a series of conversational goals and the plans or strategies which conversational participants develop to achieve them” (Roberts 2012, p.3). While nothing hinges on the choice of this particular theory, I will couch my discussion within it as it is among the best-developed theories of discourse structure.

First, I adopt the assumption that in order to accomplish CONVERSATIONAL GOALS, interlocutors need to not only understand the meaning of individual utterances in the discourse, but they are also required to identify the questions that these utterances answer. Importantly, interlocutors situate the questions in a STRATEGY OF INQUIRY, in order to ultimately meet their conversational goals.

Second, for a discourse to be felicitous, it must be COHERENT. To this end, it is assumed that there is a non-optional process of establishing discourse coherence by inferring what questions the speaker has chosen to set up and address, and why these questions are chosen. A coherent discourse is subject to various well-formedness constraints on the structure. Here, I adopt the following formal notion of COMPLETE ANSWER, defining it relative to a question:⁸

- (63) For any proposition p , and any question Q :

$\text{COMPLETEANSWER}(p, Q)$ iff there is exactly one q (a cell) in Q such that p entails q

I take the COMPLETEANSWER condition to be an organizing principle of discourse which supports coherence. For a discourse to be coherent, COMPLETEANSWER must be obeyed. For a declarative (i.e., an assertion), it must answer the current question as defined in (63) in a discourse. Importantly, however, only semantically asserted content can readily answer a question; non-asserted content, including presuppositions, cannot be used to answer or address a question (Potts 2005; Amaral et al. 2007; Simons 2001; Simons et al. 2010; Simons et al. 2017; AnderBois, Brasoveanu, & Henderson 2015; Beaver et al 2017; a.o.). This independently motivated generalization is important for understanding the key contrasts.

By itself, the COMPLETEANSWER condition appears to be overly strict, and thus will not be appropriate for accounting for many discourses where the condition does

⁸This definition amounts to how complete answers are defined in Groenendijk & Stokhof 1984.

not seem to be met, yet the discourse still appears to be coherent. Thus, we will need to accompany it with Question Accommodation (Cooper et al 2000; Cooper & Larsson 2010; Velleman & Beaver 2016; Bledin & Rawlins 2019). The basic idea, building on Lewis's (1979) notion of presupposition, is that implicitly introduced questions subserve the “practical goals and interests of the speakers.”

- (64) QUESTION ACCOMMODATION: Implicitly introduced questions can be accommodated by the listener in order to make the discourse coherent. Such questions must subserve the communicative goal of the conversation and form a good line of inquiry in the discourse structure.

On this view of question accommodation, there are discourses which, on a first look, appear to violate the COMPLETEANSWER condition as defined in (63), but these violations are implicitly resolved or repaired, and thus discourse coherence preserved, once we infer and accommodate an implicit question we are accommodating. I will refer to such questions as *Bridging Question*. To see how this may work, let's consider the following Question-Answer pair:

- (65) Q: Why are the first-year students not at the colloquium party?
A: Well, Peter is doing this week's p-sets in his office.

Assume Peter is one of the first-year students. The answer in (65) does not straightforwardly satisfy the COMPLETEANSWER constraint as defined above: I take Q to be a question about causes (answered with ‘because’, rather than goals which are answered with ‘in order to’), and there is a single Hamblin answer to this why-question (Schwarz & Simonenko 2018). The q in Q thus should denote one single answer listing the reason(s) for the first-year students' absence from the colloquium party, including Peter's. Thus, the proposition denoted by the answer in (65) does not entail q ; it's the other way around. COMPLETEANSWER is not satisfied. However, we do

not feel that the discourse is an incoherent one. We may understand its underlying discourse structure in the following way: in this case, the speaker does not actually have sufficient knowledge or information to answer the question Q , but they do have sufficient knowledge/information to answer Q' , and Q' provides a strategy of inquiry for the ultimate conversational goal of figuring out Q . Thus, Q' is inferred as a bridging question, and the underlying discourse structure of (65) including this bridging question will look like (66):

- (66) Q: Why are the first-year students not at the colloquium party?
[Q' : Why is Peter not at the colloquium party?]
A: [I don't know the answer to Q , but I have information to answer Q' ;]
Well, Peter is doing this week's p-sets in his office.

Crucially, utterances invoke implicit questions by virtue of their form. I adopt Singh's (2007) view that candidates of accommodation are subject to formal restrictions (see also Katzir 2007, Fox & Katzir 2011, Katzir & Singh 2013, 2015, a.o.); this kind of analysis of question accommodation involving formal alternatives is rather syntactic in nature, and puts constraints on what questions can be accommodated (and where) in the discourse structure. For instance, Katzir & Singh (2013) reasoned that when utterances are provided in isolation (or the so-called “out-of-the-blue” context), the task of reconstructing such a context is left to the listener, which involves in particular the reconstruction of a reasonable question. For the following examples from Geurts (1996):

- (67) a. If all the boys failed the exam, then it wasn't only Fred who did so.
b. If all the boys left together, then the janitor will not have noticed that
Fred left.

Katzir & Singh (2013) assume that a reasonable question that can be reconstructed in

such cases will be from the consequent of the conditional in each case, which already happens to presuppose p .⁹ Thus, it is difficult to conclude based solely on (67) that p is the result of projection, as advocated in theories like Geurts (1996). A general lesson that we may take away from this is that it is crucial to identify what salient questions the listener may be reasoning about in the context (including “out-of-the-blue” contexts), because accommodated questions are a potential confound when we try to determine where the stronger presupposition is coming from in a discourse.

I think this lesson from Katzir & Singh can be extended to the interpretation of the Mandelkern examples. Let me first repeat below the data that form our key contrasts. First, the “baseline” example in (68) which contrasts with the Mandelkern-style example in (69), with their difference being that the proposition p , “Sam is a musician”, is asserted content in the consequent of (68) but presupposed in the same position in (69):

- (68) [We don’t know what Sam does for a living. He could be a musician, a teacher, or a painter. We are hoping to find out more about him at a party.]
 If Sam brings a guitar to the party, he is a musician and he is proud of being one.

- (69) [We don’t know what Sam does for a living. He could be a musician, a teacher, or a painter. We are hoping to find out more about him at a party.]
 ??If Sam brings a guitar to the party, he is proud of being a musician.
- a. *If Sam brings a guitar to the party, he is a musician.*
 - b. *Sam is a musician. [felt presupposition]*

Then, contrasting (69) with (70), which minimally modifies the context by adding the sentence, “We also don’t know how he feels about whatever it is that he does.”

⁹By itself, this is not satisfactory, as it leaves open the question why the question cannot just be a conditional question, i.e., the interrogative versions of (67-a) and (67-b).

Unlike (69), in (70) we do *not* feel that the non-conditional presupposition in (70-b) is there.

(70) [We don't know what Sam does for a living. He could be a musician, a teacher, or a painter. We also don't know how he feels about whatever it is that he does. But let me tell you a few things:]

If he comes with a guitar, he is proud of being musician. (If he comes with a ruler in hand, he is a very funny teacher.)

- a. *If Sam brings a guitar to the party, he is a musician. [felt presupposition]*
- b. *Sam is a musician.*

Let us assume that minimally, the following two components are involved when we consider how we should represent the discourse structure of the data under discussion:

(71) *Q*: a highly salient question in the context, the goal of the conversation.

(72) *If ϕ , ψ* : the conditional assertion in the context of *Q*, where ϕ is the antecedent and ψ is the consequent (which may contain a presupposition trigger).

I take these components to be shared across the three key examples. Consider an initial, rough representation of the discourse structure in the key examples like the following, which we will revise later for individual examples:

(73) INITIAL STRUCTURE:

Q?	[Is Sam a musician?]
If ϕ , ψ	[If Sam brings a guitar,]

To preview the key contrasts: (i) the difference between (68) and (69) is due

to the different semantic relations between ψ and q : ψ “he is a musician and he is proud of being one” entails q in (68), satisfying COMPLETEANSWER, whereas in (69) ψ “he is proud of being a musician” presupposes q ; (ii) the difference between (69) and (70) is because in (70), the added sentence that minimally modifies the context (but importantly, did *not* change what’s entailed on the common ground) suspends the original question “Is Sam a musician?”, which is replaced by a different salient question, Q' , “How does Sam feel about his profession?”, and as such ψ entails q' , satisfying COMPLETEANSWER.

To see how these differences affect the establishment of discourse coherence in each case, let us begin by considering how the interlocutors try to achieve their conversational goals in the discourses under discussion. In a context where there is a salient question, Q , why does the speaker assert a conditional statement, *If* ϕ , ψ ? As a listener, how should we make sense of such a discourse move made by the speaker, under the general assumption that they are being cooperative and trying to move the conversation toward a shared communicative goal? I take the ultimate goal of such a conversation to be finding out the answer to Q , and in the situation where a complete answer to Q is not available (and it is on the common ground that we currently don’t have enough information to answer Q), the reasonable next move is to ask: well, what additional information should we obtain, or what kind of things can we do, that will help us move forward in the direction of figuring out Q then? In other words, how do we establish a reasonable line of inquiry for Q , our ultimate conversational goal?

I suggest that to make sense of the speaker’s assertion of *If* ϕ , ψ in a context where there is a salient question Q , the listener (i) first infers that the speaker does not have the complete answer to Q , and (ii) then infers that the speaker is providing what they believe to be a reasonable line of inquiry, by answering instead an implicit, bridging question *If* ϕ , Q , which is a conditional question sharing the same antecedent

as the speaker's assertion *If* ϕ , ψ . To represent this update of the discourse structure schematically:

(74) REVISED STRUCTURE:

Q?	[Is Sam a musician?]
If ϕ , Q?	[If Sam brings a guitar, is he a musician?]
[If ϕ , q] [If ϕ , $\neg q$]	
If ϕ , ψ	[If Sam brings a guitar,]

This new component of the bridging question is now brought into consideration in (74). A speaker responds to the situation where there is a highly salient question Q by uttering *If* ϕ , ψ , which clearly does not settle Q . As a listener, we infer that it must be that the speaker doesn't have enough information to actually answer Q . The speaker is still trying to provide a reasonable line of inquiry that will hopefully help us move toward our conversational goal: perhaps we just need some additional information before we can answer Q ; let's say, if we assume that ϕ holds, perhaps we will be able to answer Q then? Following this line of reasoning, an assertion of *If* ϕ , ψ in the said context cannot by itself answer Q , so the listener infers that the speaker is instead answering an implicit, bridging question, *If* ϕ , Q .¹⁰

Why is *If* ϕ , Q the bridging question though? Why not, for example, just the interrogative counterpart of *If* ϕ , ψ ? Here, again, we must consider what constitutes a good line of inquiry, and specifically a line of inquiry for Q , the question that is salient by the context. The bridging question must be one that can effectively help us move toward a better understanding of *how* we can go about answering Q , or put

¹⁰For the semantics of conditional questions, I adopt the meaning from Issac & Rawlins (2008) who argued that the interpretation of a conditional question involves two steps. In the first step, we make a temporary copy of the current context c , and update the copy with the propositional content of the antecedent; in our case, c is updated with ϕ ; the worlds where ϕ is false is not our concern for the remaining computation. In the second step, the question in the consequent raises an issue relative to the temporary context, i.e., it partitions the temporary context; in our case, the question in the consequent is Q , which is now raised relative to c' where ϕ holds.

us into a better position where we will then be able to answer Q . In this sense, the conditional question with Q as the consequent serves exactly this purpose. As for the antecedent of the conditional question ϕ , how can we go about finding out Q , i.e., what Sam does for a living? Perhaps we can do a bit of detective work of our own and try to observe various aspects of his life. There may be multiple candidates of observation: perhaps we will notice that he has a tattoo of a musical note, or he often makes loud instrumental sounds at night, or maybe he will bring a guitar to the party tonight. Among these, of our current interest is the possibility that he will bring a guitar to the party (i.e., our ϕ). If so, then with some “detective-style reasoning”, perhaps we can then answer Q (with varying degrees of confidence, depending on the strength of the “detective-style reasoning” involved). This then makes *If* ϕ , Q the only bridging question that forms a good line of inquiry in the discourse under consideration. The bridging question must be answered.

We then need to evaluate the relationship between the bridging question *If* ϕ , Q and the conditional assertion *If* ϕ , ψ . Recall the definition we have for the COMPLETEANSWER condition for question-answer pairs:

(75) For any proposition p , and any question Q :

COMPLETEANSWER(p, Q) iff there is exactly one q (a cell) in Q such that p entails q

For a discourse to be coherent, (i) the current question must be answered; (ii) the answer must satisfy the *CompleteAnswer* condition for its salient question in the sense of (75); (iii) presupposed information cannot be used to answer or address a salient question.

We are now in a position to distinguish (68), in which p is asserted content in the conditional consequent, from the peculiar Mandelkern-style discourse in (69). In (68), the COMPLETEANSWER condition is satisfied because its conditional consequent ψ ,

“he is a musician and he is proud of being one”, entails q “Sam is a musician”. Thus, $If \phi, \psi$ provides an answer for the conditional question $If \phi, Q$. Since the information being used to answer the question is asserted content, there was no interruption to coherence. By contrast, in (69), the conditional consequent ψ “he is proud of being a musician” presupposes q “Sam is a musician”. Due to (iii), $If \phi, \psi$ cannot be an answer to the conditional question $If \phi, Q$. The discourse in (69) remains incoherent at this step of evaluation.

The two cases — (68) and (69) — thus differ in whether they satisfy *CompleteAnswer* given an accommodation question in the form of $If \phi, Q$. But in the case of (69), we must revise the discourse structure to figure out what the speaker’s assumptions are, such that the discourse can be understood as a coherent one. One option that the listener can still resort to is figuring out what other question the speaker must have chosen to set up and address instead. Given $If \phi, \psi_p$, what question can we accommodate that will help us establish coherence successfully? Since utterances invoke implicit questions by virtue of their forms, the revision of implicit questions is also form-based. Given $If \phi, \psi_p$ (“If Sam brings a guitar, he is proud of being a musician”), we may infer that this assertion must be providing a complete answer to some question. The question that $If \phi, \psi_p$ can provide an answer to while satisfying *COMPLETEANSWER* is $If \phi, Q'$: “If Sam brings a guitar, is he proud of being a musician?”

(76) REVISED STRUCTURE II:

$Q'?$	[Is Sam proud of being a musician?]
$If \phi, Q'?$	[If Sam brings a guitar, is he proud of being a musician?]
$[If \phi, q]$	$[If \phi, \neg q]$
$If \phi, \psi$	[If Sam brings a guitar, he is proud of being a musician]

What (76) represents is a step-by-step revision of the discourse structure that

reflects how a listener, in order to establish discourse coherence, may infer what alternative question(s) the speaker appears to have chosen to set up and answer, given their utterance. The revised discourse structure now has Q' . This accommodated question has a non-conditional presupposition, “Sam is a musician”. In other words, the outcome of this revision that satisfies the COMPLETEANSWER condition and establishes discourse coherence is one in which the speaker already takes for granted that “Sam is a musician”.

On the view I am advocating here, the non-conditional inference from Mandelkern-style examples like (69) does *not* come directly from presupposition projection out of the conditional assertion *If* ϕ , ψ_p , and it is *not* obtained via pragmatic strengthening of a conditional presupposition. It is the presupposition of the accommodated question in the revised discourse structure. This non-conditional presupposition p is at odds with ignorance about the matter in the context: we end up presupposing more than we should, but only as a result of our obligation (as a listener) to ensure discourse coherence, in a situation where we have no reason to assume that the speaker is being uncooperative. This process takes priority, and the discourse ends up being infelicitous.

We still have to explain(70), which does not yield infelicity in the same way¹¹. In (70), the only difference from the typical Mandelkern-style example is that the context has an additional sentence, “We also don’t know how he feels about whatever it is that he does.” The conditional assertion *If* ϕ , ψ_p is exactly the same. An insight about this difference between (69) and (70), first noted by Fox (2019), is that in the latter case, a different question is being made salient in the context. More concretely, I suggest that this modification to the context effectively suspends the original Q about what is Sam’s profession, due to (at least in part) the indifference inference coming from “whatever it is that he does”. The question about what is Sam’s profession,

¹¹See also a few more similar examples in Fox (2019).

and whether he is a musician or not, is no longer operative, and gets replaced by a different question in (70), Q' , “How does Sam feel about his profession?” This has ramifications on discourse coherence.

I assume that questions like “How does he feel about x ?” and “How does he like x ?” has various polar questions as sub-questions, “Does he like it?”, “Is he proud of it?”, etc. (The specific question we infer is also based on the form of the utterance/answer.) Thus, in the case of (70), the conditional’s consequent ψ “he is proud of being a musician” also entails q' “he (=Sam) is proud of his profession”, and as such *If* ϕ , ψ can satisfy the COMPLETEANSWER condition and provide an answer to the bridging question *If* ϕ , Q' , which we infer as the line of inquiry that the speaker sets up for the conversational goal of answering Q' , a salient question that remains operative.

(77) DISCOURSE STRUCTURE:

$Q?$	[Is Sam a musician?; suspended]
$Q'?$	[Is Sam proud of his job?]
$\text{If } \phi, Q'?$	[If Sam brings a guitar, is he proud of his job?]
$[\text{If } \phi, Q']$	$[\text{If } \phi, \neg Q']$
$\text{If } \phi, \psi$	[If Sam brings a guitar, he is proud of being m]

4.2.4 Limitations

The proposed idea as it stands is provisional and still suffers from many stipulations and limitations. First, generally speaking, what are the conditions that govern what questions can and cannot be accommodated? This is part of the larger enterprise to develop a better understanding of question accommodation, which we will not attempt here but merits further scrutiny in future work. Second, specifically for accommodated questions that are conditional, more needs to be said about when

such conditional questions only serve as part of a line of inquiry for a higher-level non-conditional question, *versus* when they are themselves the conversational goal. While I have not said much about this so far, my current thinking on this issue is that it depends on whether the connection between the antecedent ϕ and Q in the consequent is common sense knowledge — in which case the mention of ϕ is to help us figure out Q — or whether this connection is unknown, but crucially of interest, to the discourse participants. As a contrasting example, imagine that we are gossiping about our friend Mary who may be having a crush on John, and there is a party this upcoming Friday. It may well be the case that a conditional question like “If John comes to the party, will Mary come to the party?” is itself the conversational goal — as a gossiper, what I’m most interested in finding out is not whether John will actually come, or whether Mary will actually show up at the party, but the connection between these two events, because that is what gives me a clue about whether the rumor of Mary’s crush on John is true. I think this is a case where the conditional question itself is the ultimate salient question in the context. By contrast, in the conditional questions we have been discussing, the connection between ϕ and Q is clear to the discourse participants, i.e., there *is* such a connection, and in fact we are using that knowledge as part of our attempt to figure out Q. This detail shall be further worked out in order for us to develop the current proposed idea into a full explanation.

4.3 Responding to Mandelkern

Mandelkern (2016b) raised an objection to using general pragmatic considerations to explain his data. I would like to address this objection given my idea, but I am only doing so in the spirit of highlighting the differences between my idea and existing QUD-based objections. For ease of reference, in this section the numbering of the

examples follows Mandelkern (2016b).

To recap the plot as outlined in the original paper, let's first revisit the example under discussion in (11), for which the detective is felt to presuppose (12):

(11) [It is common ground that Smith has gone missing, and we don't know whether he is still alive. A detective enters and says:] If the butler's clothes contain traces of Smith's blood, then it was the butler who killed Smith.

(12) Someone killed Smith.

Mandelkern confirms the intuition that a commitment to (12) is at play by applying the HWAM test in (13):

(13) Hey wait a minute! I didn't know someone killed Smith!

However, under the asymmetric theories of projection, (11) semantically presupposes (14):

(14) The butler's clothes contain traces of Smith's blood \supset Someone killed Smith.

Furthermore, this should be the felt presupposition of (11) since the pragmatic strengthening mechanism as standardly assumed is not expected to kick in: (14) is by no means a strange conditional, and there is no independence relationship between "the butler's clothes containing traces of Smith blood" and "Smith was murdered".

In other words, there is no reason to think that (14) should be strengthened to (12).

Mandelkern (2016b) dismisses an attempt to use general pragmatic principle to explain the data in footnote 26 (p.12), which I quote below:

"A different way of attempting to use general conversational practices to explain the strengthening in question is to argue that, were we to impute to the detective the intention to communicate only the conditional

(14), we would treat her as presupposing something that addresses an implicit question under discussion (QUD): something like how can we find out whether Smith was killed?. This kind of conversational move is generally marked: QUDs should be addressed by asserted, not presupposed, content. And so there is pressure to avoid treating the speaker as presupposing (14). This line of response is fairly easy to dismiss, however. Two observations are key here. First, (12) entails (14). Thus if (14) answers QUDs in an objectionable way, then so does (12). Of course, this line of argument only goes through if, as we are assuming, the presupposed conditional is a material conditional. But even if we abandon that assumption, note that, second, in addition to whatever QUDs (12) answers insofar as it entails (14), (12) also answers a further QUD: whether Smith is dead. Thus, if the conditional reading of (11) were infelicitous on the grounds that it answers a QUD with presupposed content, we would expect the unconditional reading to be even less acceptable, since (12) answers every QUD that (14) does, and more. It follows, first, that we cannot explain a selectional pressure for the unconditional over the conditional reading on the grounds of the present considerations.”

The objection of a QUD-based explanation as stated above is that, given the principles governing the *selection* of the conditional and the non-conditional presuppositions, we cannot possibly be choosing the non-conditional one *over* the conditional one as the presupposition of the assertion in these data. This is because, as Mandelkern correctly pointed out, (12) answers every QUD that (14) does, and as such one cannot explain a selectional pressure to favor the non-conditional presupposition over the conditional one.

What I would like to point out is that the line of arguments in this objection is built upon the premise that the case in question is just another case of pragmatic

strengthening; in other words, the non-conditional presupposition is obtained via the strengthening of the conditional presupposition. However, under the view I'm advocating here, the non-conditional presupposition is *not* from the conditional assertion itself, and not the result of selectional pressure at all. It would thus be misleading to call these cases “unexpected strengthening”, as they are not actually the result of strengthening to begin with. It follows that unsurprisingly, they are not affected by standard considerations that typically regulate the strengthening mechanism.

The felicity of the HWAM test in (13) as a response to the discourse in (11) is because, through the listener’s reasoning of the discourse structure, the speaker in (11) is indeed thought to have committed themselves to (12) — not based on the conditional assertion in (11), but because the listener reasoned that the assertion must mean that the speaker actually set up a line of inquiry that ultimately presupposes (12), given our considerations of COMPLETEANSWER. We call this into question in (13). The HWAM test helps us identify the status of the inference in (12): it is information being taken for granted, a presupposition. But on its own, the test doesn’t tell us where the presupposition is coming from. Once we start exploring new perspectives on the source of the non-conditional presupposition, we can see that these data are not incompatible with the asymmetric theories of projection, which postulate $If \phi, p$ as the semantic presupposition of $If \phi, \psi_p$. The present account thus serves to supplement the asymmetric theories with additional considerations for discourse structure.

4.4 Implications on the theory of projection

The discussion of the Mandelkern-style data, along with its minimal pairs, is couched within the context of our attempt to defend the asymmetric theories of projection: can these data really be taken as definitive argument to reject the asymmetric view? These

theories systematically make a weak prediction about the (semantic) presupposition projected out of $If \phi, \psi_p$ in the proviso cases and in the Mandelkern-style data. But while a conditionalized presupposition is predicted, a stronger, non-conditional presupposition p is felt in these cases. This has been taken by Mandelkern to be a major weakness. In particular, the additional mechanism of pragmatic strengthening that has been used to address the proviso cases seems insufficient for accounting for the Mandelkern-style data.

If the idea being developed in the present account turns out to be on the right track, it will supplement the asymmetric view with additional considerations for question accommodation and discourse structure, to explain the Mandelkern-style examples: It explains discourse infelicity in the Mandelkern-style example by appealing to the idea that COMPLETEANSWER is violated due to using presupposed information to answer the bridging question $If \phi, Q$, which prompts a non-cancellable process of revising the discourse structure to accommodate a new question, in order to preserve coherence. This ultimately leads to a non-conditional inference p , which conflicts with ignorance about the matter in the context. On this account, the insights of the asymmetric view with respects to projection can be kept intact: the conditional presupposition is still the semantic presupposition of $If \phi, \psi_p$; the pragmatic strengthening mechanism isn't applicable in these Mandelkern-style data.

The question-based explanation I advocate for here crucially appeals to the role of context and discourse structure, and makes two predictions that I think are favorable, which I turn to next.

4.4.1 The role of context

The present account crucially appeals to the role of a salient question, while in “null contexts”, it has been assumed to be just the “Big Question”, i.e. “What is the way things are?”(Roberts 2012). Given our definition of COMPLETEANSWER, the Big

Question itself is unanswerable: there is no answer that will be considered to satisfy COMPLETEANSWER, because there cannot be exactly one cell in “What is the way things are?” such that the proposition p entails it. The proposition p will just be the answer to a subquestion of the Big Question, which minimally can just be a polar question about p . In other words, when presented in null contexts, and the data does not otherwise have any special discourse structure (e.g. as indicated by intonation), we do not anticipate any violation of the COMPLETEANSWER condition to interfere in the process of establishing coherence. This is indeed the way classic examples involving conditional presuppositions are presented, such as (78):

- (78) If Sam is a musician, you can play your favorite song using his guitar.

Presupposes: If Sam is a musician, he has a guitar.

We thus predict that we can manipulate the context in such a way that classic examples like (78) will wind up looking like a Mandelkern-style example. We have the recipe to make this happen: the key will be to set up the right Q , ensure that it is operative, and that the presupposition embedded in the consequent ψ but not ψ itself can answer Q . We construct such a context in (79), where there is a highly salient question about whether Sam has a guitar:

- (79) Justin: I am hosting a party this weekend, but I don’t have a guitar. I need to know if my new neighbor Sam has a guitar that I can borrow. Does he have a guitar, I wonder?

Justin’s colleague:

- a. If Sam is a musician, he has a guitar and you can play your favorite song with it.
- b. ??If Sam is a musician, you can play your favorite song using his guitar.

Against this context, we have a minimal pair of (79-a) and (79-b), parallel to the kind we've seen before: an utterance of (79-a) by Justin's colleague, in which "Sam has a guitar" is part of the asserted content of the conditional consequent, is a fine response to the context; an utterance of (79-b), however, is quite peculiar, and importantly leaves us with the intuition that Justin's colleague is already committed to Sam having a guitar. We can felicitously respond to (79-b) with the HWAM test:

- (80) Justin: Hey wait a minute! I didn't know Sam has a guitar?!

Furthermore, we can once again minimally modify the context such that the question "Does Sam has a guitar" is suspended, and a different question becomes operative such that the very same utterance should be not only felicitous but also *not* make us feel that Justin's colleague is "overcommitted". We can indeed do so in (81):

- (81) Justin: I am hosting a party this weekend, but I don't have a guitar. I need to know if my new neighbor Sam has a guitar that I can borrow. *Whether he does or not, in any case, I wonder which song I should really perform tonight at the party.*

Justin's colleague: If Sam is a musician, you can play your original song using his guitar. (If he is a PhD student, you won't be able to perform at all and will have to listen to him talking about his boring research all night.)

- a. If Sam is a musician, he has a guitar. [felt presupposition]
- b. Sam has a guitar.

We minimally modify the context by adding "Whether he does or not, in any case....", with the goal that this suspends the original question about whether Sam has a guitar. Informants reported that there is a contrast between (80) and (81): in the latter, Justin's colleague can go on to talk about what happens if Sam isn't a

musician, or even more directly, the conversation can continue into discussing what other options are available if nobody can bring a guitar (“...I will bring my keyboard so you can still perform.”). Neither feels infelicitous as a continuation, and both indicate that there is no commitment to the inference in (81-b) on the part of the speaker, i.e., Justin’s colleague. Thus, I take this to suggest that we have the correct recipe which “demystifies” the Mandelkern-style examples and allows us to recreate them easily.

4.4.2 Focus

In addition to manipulating the context, I suggest that we can also find examples with stronger-than-expected presuppositions by introducing special focus structures into the utterance. For focus-related phenomena, I adopt a notion of Congruence roughly in the sense of Roberts (2012):

- (82) For any proposition p , and any question Q :

CONGRUENT(p, Q) iff its focal alternatives $\|p\|$ are the q-alternatives determined by Q , i.e., iff $\|p\| = \text{q-alt}(Q)$.

Along with this definition, I assume that the prosodic focus on an utterance gives rise to the presupposition that the utterance is congruent to the salient question.

I argue that further data points in (83) involving focus corroborate the idea that question accommodation and discourse structure play a key role in obtaining the non-conditional inference, independent of processes like pragmatic strengthening. Take (83-a) as our baseline, in which the antecedent “John is a Catholic” and the embedded presupposition in the consequent “He has a Bible” are not independent from each other, and as the asymmetric view correctly predicts only a conditional presupposition is projected. But (83-b) and (83-c) both show a contrast with (83-a): in (83-b), prosodic focus is placed on “read” and in (83-c) on “every”; in both examples, there

seems to be a quite salient, non-conditional presupposition, “John has a Bible”.

- (83) a. If John is Catholic, he'll read his Bible.

Presupposes: If John is Catholic, he has a Bible

- b. If John is Catholic, he'll READ his Bible.

Presupposes: John has a Bible

- c. If John is Catholic, he'll read his Bible EVERY night.¹²

Presupposes: John has a Bible

I take it that the independence relation did not change from (83-a) to (83-b-c). As such, they are unlikely to be a simple case of pragmatic strengthening: any vanilla version of the asymmetric view will also have a hard time explaining why a stronger-than-expected presupposition obtains in (83-b-c), unless we once again give additional considerations to discourse structure. Asymmetric theories will systematically predict that the semantic presupposition in (83-b-c) is “If John is Catholic, he has a Bible”, and since pragmatic strengthening isn't licensed to kick in here, this presupposition is not expected to be strengthened to “John has a Bible”.

I suggest that there is a different way to think about the data in (83), given the focus structures in (83-b-c), the notion of Congruence we adopted, and the idea that an utterance gives rise to the presupposition that the utterance is congruent to the salient question. We can reason that the plausible bridging questions for (83-b) and (83-c) will take the following forms:

- (84) For (83-b): What will John do with his Bible if he is Catholic?

For (83-c): Which nights of the week will John read his Bible if he is Catholic?

(83-b) invoke a salient question with q-alternatives that include all the things John will do with his Bible if he is Catholic; (83-c) invoke a salient question with q-alternatives

¹²Narrow focus reading of ‘every night’ intended

that include the possible schedules of John reading his Bible if he is Catholic. Again, these conditional questions are questions raised relative to a temporary context (i.e., that of the antecedent). In line with our account, we may further reason that such conditional questions are being set up because they serve as a reasonable line of inquiry for a higher-level question in the discourse — presumably a question about the consequent, which takes a non-conditional form. These non-conditional questions are the questions that the listener can reconstruct, and they have a non-conditional presupposition, “John has a Bible”. Thus, as a listener, we apply this reasoning to help us figure out what is the most plausible question that the speaker has chosen to set up and address, and end up with a presupposition of p which we take to be projected out of these accommodated questions.

In other words, the examples in (83-b-c) with special focus structures have a non-conditional presupposition, unlike the “basic” case in (83-a), even though considerations for pragmatic strengthening are also not applicable there (i.e., independence relations remain the same). By contrast, the baseline example (83-a) without any preceding context or special focus structure again has the Big Question as its salient question, and since the Big Question is never answerable under the adopted notion of COMPLETEANSWER, we infer a bridging question which is simply the interrogative version of the conditional in (83). The present account also explains these contrasts as a result of question accommodation, while preserving the core aspects of the asymmetric view of projection. A full investigation into these problems awaits.

4.4.3 Conclusions

To conclude, in this chapter, I have pursued an idea to develop a question-based explanation of the Mandelkern-style data, inspired by insights in Fox (2019). In doing so, I defend the asymmetric view which includes theories that postulate a conditional presupposition $If \phi, p$ as the semantic presupposition for $If \phi, \psi_p$, and

remove the motivation to opt for an alternative theory that treats the non-conditional presupposition p as the basic one. Situating the present discussion in the context of our experimental findings in Chapters 2-3, I defend the asymmetric view of projection as the correct one that underlies the theory of presupposition projection.

Chapter 5

Conclusions and Implications

To end this dissertation, I will first provide a summary of the findings from preceding chapters, and discuss the implications for theories of projection, processing of presuppositional phenomena, and pragmatic development.

5.1 Summary of findings

In this dissertation, I set out to gain a better understanding of presupposition projection, with the goal of providing further support in favor of the asymmetric view of projection. I turned to two novel sources of evidence: online processing and language development. Focusing on if-conditionals and disjunctions, I asked whether we can find ways of disentangling the semantic presupposition from additional pragmatic mechanisms (e.g., strengthening, weakening) by (i) looking at implicit measures like response times, and (ii) looking at a pragmatically less savvy population.

Part of the difficulty in answering the first question lies in the fact that the empirical landscape is far from clear and speakers' intuitions often seem unreliable (Soames 1976; von Fintel 2004), due to the availability of additional processes: the local accommodation process can be applied to weaken the presuppositional requirements; meanwhile, the pragmatic strengthening process may kick in, resulting in a stronger

presupposition than what the projection algorithm derives as the semantic presupposition.

I compared two different views on what is the basic, semantic presupposition projected out of *if*-conditionals and disjunctions: on the asymmetric view, the presupposition projected out of the left argument of these binary connectives is a non-conditional one, but the presupposition projected out of the right argument is weaker, taking a conditionalized form; on the symmetric view, a non-conditional presupposition is the semantic presupposition projected from both arguments of the same binary connectives. In Chapter 2, I used processing evidence to identifying the deployment of additional processes during in evaluating the presupposition of a complex sentence. I found a host of evidence suggesting that the real-time processing of presupposition projection out of *if* and *or* is asymmetric in nature: the application of local accommodation is asymmetric, incurring more cost in the left argument compared to the right argument. These findings are taken to be in favor of the asymmetric view.

Similarly, child language data can help shed light on our key question. Previous developmental work has suggested that children are less adept at accommodation strategies compared to adults (Zehr et al. 2016; Tieu et al. 2018). In this sense, child behavior is relatively uncolored by the possibility of accommodation, which may complicate adult language use, and thus may unveil the underlying projection principles in a more transparent manner. In Chapter 3, I found that 6-year-olds showed a sophisticated command of presupposition projection out of *if*-conditionals: not only do they have adult-like understanding of the semantics of presupposition projection in this environment, but they can also recruit local accommodation to avoid presupposition failure. However, at the age of 5, at least some children are still at a stage where they have not yet mastered local accommodation, revealing an environment-based asymmetry in child language data: when the embedded presupposition from the antecedent environment is not globally satisfied, some children uniformly rejected the

sentence as being acceptable for the outcome, compared to the consequent environment where no child behaved in the same manner. This is also more compatible with the asymmetric view which predicts a stronger basic presupposition for the antecedent of *if*-conditionals.

In Chapter 4, I then engaged more deeply with the second question about the kind of pragmatic factors that can come into play to affect the strengthening of a presupposition. The discussion centers around a set of data presented in Mandelkern (2016a, 2016b) dubbed “unexpected strengthening”, where the classic notions of pragmatic strengthening do not appear to be applicable, yet a stronger, non-conditional inference arises from discourses involving an utterance that takes the form of *If* ϕ , ψ_p . These data appeared difficult to reconcile with the asymmetric theories that deliver weaker presuppositions, which I showed a host of evidence in favor of in preceding chapters. I proposed an alternative view on these data, and argued that they do not necessarily problematize the notion of pragmatic strengthening, but instead simply highlights that the presuppositional status of some content depends on third-party properties, such as discourse structure and question accommodation (Simons 2001; Simons et al. 2010; Simons et al. 2017; Beaver et al. 2017). Specifically, I argued that the non-conditional presupposition from the Mandelkern examples does not in fact come from presupposition projection out of the conditional assertion, but is the presupposition of an accommodated question that results from a non-optional process of establishing discourse coherence. In other words, this presupposition is not obtained via the pragmatic strengthening of a conditional presupposition, and thus it is not surprising that standard considerations for pragmatic strengthening do not apply. Such an account removes the motivation to opt for a projection algorithm that derives the non-conditional presupposition p as the basic one for *If* ϕ , ψ_p , and supplements the asymmetric view which postulates a conditional presupposition *If* ϕ , p as the basic one.

5.2 Theoretical Implications

Debates and controversies about the properties of projection environments continue to this date. In part, this is due to the complexity of potential additional processes involved, such as local accommodation and pragmatic strengthening, which are not always transparently detectable in introspective judgements. As Karttunen (2016) humorously puts it, “In trying to find cases to test [complex presuppositional sentences] with students, I have found that people tend to have much better intuitions about money than truth-value gaps.”

My goal is not to argue that we have no intuitions about truth-value gaps, or data based on intuitive judgements about presuppositions are never useful; these are simply not true. However, I do think that we can and should combine a variety of methodologies to put our theories to test. Processing data can be used to detect the deployment of additional mechanisms that are costly, and child language data can reveal the underlying properties of the projection mechanism more transparently. Both types of evidence serve the purpose of arbitrating between competing theories of presupposition projection. Ultimately, the correct theory of projection should be compatible with these experimental findings.

The primary finding of this dissertation is that processing and developmental data can receive a straightforward explanation under the asymmetric theories of projection. These experimental results are challenging to explain on the alternative view that the basic, semantic presupposition projected out of binary connectives is a strong, non-conditional one, which underlies the symmetric view of presupposition projection. In many ways, the symmetric theory is very appealing: a simple, principled compositional semantics (with the exception of DRT), together with a few independently motivated pragmatic principles. But if our conclusions from the experimental results are on the right track, the symmetric theory is descriptively inadequate, and thus less superior than asymmetric theories which derive a weak presupposition for the right

argument of binary connectives. Proponents of the symmetric theories will need to address how a collection of all these findings can be explained in their systems.

5.3 Processing Implications

While much experimental work to date investigating presuppositional phenomena has relied solely on offline data like felicity judgements, such behavioral measures are likely to be too coarse for identifying the underlying mechanisms responsible for producing presupposition projection. Following the spirit of von Fintel (2008, 2004), I take the problem of presupposition projection to be a semantic problem, and it is of paramount importance to pinpoint the division of labor between semantics and general pragmatic reasoning. But offline behavioral measures often conflate semantic judgements with additional processes, such as global and local accommodation.

Meanwhile, online behavioral measures such as response times may allow us to more precisely identify the deployment of such processes, thereby revealing the basic projection pattern. In particular, we also found that the application of local accommodation incurs processing costs, in line with previous research (Chemla & Bott 2013; Romoli & Schwarz 2015; Zehr & Schwarz 2016), which can be used as a key signature in evaluating complex presuppositional sentences against certain contexts. Furthermore, the time course of local accommodation may be used as a secondary processing signature, similar to the suggestion in Zehr & Schwarz (2016): the application of local accommodation can be primed, and prior, frequent access to local accommodation readings will facilitate access to parallel readings in later encounters.

In sum, while the existence of potential additional processes can complicate our investigation of presupposition projection, we can use them to our advantage to ultimately yield a more comprehensive understanding of the projection “algorithm” that is responsible for systematically deriving the presupposition of a complex construction

compositionally based on presuppositions of its subpart.

5.4 Developmental Implications

Our experiments in Chapter 3 adds to the growing body of evidence that child language can help arbitrate between semantic theories. This is because child language is often uncolored by pragmatic factors and world knowledge that complicate adult language. The child behaviors in our experiments indicate that at the age of 5, children have already mastered the rules of presupposition projection for *if*.

The question of how children come to know rules of presupposition projection and accommodation is part of a much broader question of how children's mind develop, but the learner's challenge is at least two-fold. First, complex presuppositional sentences are scarce in child-directed speech, so in the early stage of life, the child is exposed to very limited data from which they can learn the projection pattern. Second, the child may approach the task by keeping track of how certain presuppositional expressions never occur in complex constructions in a situation where the presupposition is not already part of the common ground, which is already problematic for filtering environments like the consequent of an *if*-conditionals. But even if we assume that it is the approach for learning projection, when the child finds a presuppositional expression used in a context where it is not satisfied, they still face two options: (i) they realize that they were following the wrong projection rules, from which they need to navigate away; (ii) they can instead just take such cases to be the learning environments for accommodation strategies. Thus, given the issue of data sparsity and the possibility of accommodation, it is difficult to see how projection rules can be learned.

I take the knowledge of projection that children demonstrate in their early life to be a possible illustration of the Poverty of the Stimulus argument: very young

children have knowledge of the projection algorithm, in spite of very little input which fails to provide sufficient evidence for learning the algorithm. Thus, it must be that the projection algorithm is part of the grammar that is built-in. A major learning task of the child, then, involves figuring out in which contexts they can and perhaps should accommodate an unsatisfied presupposition. This leaves open many interesting directions for future work.

5.5 Closing remarks

While we have made some progress, much work still remains. In this closing section, I point to two issues that I think warrant more attention.

First, in this dissertation, I have focused on two environments of presupposition projection: *if*-conditionals and disjunctions. Beyond these two connectives and conjunctions, there are many other complex environments that continue to present challenges for the projection problem in general, and for the asymmetric theories of projection in particular: environments such as factives, quantificational sentences, and semi-conditionals present difficulty for other instances of the proviso problem. For example, Guerts (1996) famously raises the issue that the conditional presupposition is never strengthened to a non-conditional one when embedded inside environments like factives, regardless of pragmatic considerations:

- (85) Sue knows that if John isn't tired, he has a Bible.

#Hey wait a minute, I didn't know John has a Bible!

- (85) can only have the conditional presupposition, “If John isn’t tired, he has a Bible”, despite the fact that it’d be rather implausible for a speaker to take for granted such a strange conditional. Importantly, (85) cannot be taken to presuppose “John has a Bible”, as shown by the infelicity of the “hey wait a minute” test as a

response to the utterance. This has been taken to be problematic for the asymmetric theories and pragmatic strengthening: if it is generally implausible for a speaker to be taking this type of odd conditional for granted, then why wouldn't it be possible to strengthen the presupposition to "John has a Bible" in (85)? Many authors have since then attempted to provide an explanation for this observation. Heim (2006), for example, has sketched some suggestions to account for (85) in terms of conversational implicatures that may or may not block the accommodation of the stronger non-conditional presupposition. It will also be interesting to see if the kind of question-based explanation we explored in Chapter 4 can be extended to environments like factives and beyond, which will provide a more general understanding of how third factors like discourse structure may come into play in explaining why accommodation is sometimes not minimal.

Another pressing question the remains open concerns how the ability to apply local accommodation develops in children. Previous research reports that 4- and 5-year-old children apply local accommodation at reduced rates compared 7-year-old children and adults (Bill et al. 2016; Zehr et al. 2016; Tieu et al. 2018). This is corroborated in the present work, which finds that at least at the age of 5, some children still show a departure from adult-likeness in terms of applying local accommodation, but 6-year-olds are much closer to adult-like performance. A better understanding of the developmental trajectory, as well as how child learners can move from one developmental stage to the next, is without a doubt intimately related to the question of how children develop general pragmatic abilities of reasoning what is on the common ground and what is the speaker's intention for communication.

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