

Presuppositions, Projection, and Accommodation - Theoretical Issues and Experimental Approaches

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Abstract

The present chapter reviews experimental work on presupposition, both in terms of methodological developments and the theoretical implications of experimental results. Presuppositions convey information that is typically assumed to already be taken for granted by the discourse participants. Furthermore, they are characteristically unaffected by a variety of linguistic embedding environments, such as negation, conditionals, and questions. After providing a brief background on the topic, and introducing key issues from the current literature, experimental approaches to investigating presuppositions are discussed, covering both unembedded and embedded environments, as well as the relation of presuppositions to the discourse context. The final section concludes and provides an outlook on future directions for the field.

Keywords: Presuppositions, Accommodation, Presupposition Projection, Quantifiers, Context, Discourse

Contents

1	Current Issues in Presupposition Theory	2
1.1	Basic Phenomena	3
1.2	Semantics vs. Pragmatics and Explanatory Challenges	6
1.2.1	The Triggering Problem	7
1.2.2	The Projection Problem	8
1.3	Distinguishing Types of Presupposition Triggers	11
2	Presupposition Interpretation in Experimental Tasks	12
2.1	Detecting Presuppositions Experimentally	13
2.2	Reflexes of the Status of Presuppositions	15
2.3	‘Novel’ presuppositions: To ignore, accommodate, or cancel?	17
2.4	The Timecourse of Presupposition Interpretation	21
2.5	Interim Summary	22

3	The Interpretation of Triggers in Embedded Environments	23
3.1	Identifying what Projects	23
3.1.1	Projection from the Scope of Quantifiers	23
3.1.2	Projection from Sentential Operators	24
3.2	Local Readings	26
3.3	Differences in Projection between Triggers	27
3.3.1	Soft vs. Hard Triggers and Local Accommodation	27
3.3.2	Local Readings Reconsidered: Entailment vs. Local Accommodation	29
3.4	Summary on Embedded Triggers	31
4	Presuppositions in Discourse	31
4.1	Resolving Presuppositions in the Discourse Context	32
4.2	Factives, Prosody, and Discourse	32
4.3	Obligatory Triggers	34
5	Conclusion & Outlook	35

1 Current Issues in Presupposition Theory

A central issue in the study of meaning in natural language is to capture what the different aspects contributing to the ‘overall conveyed meaning’ of an utterance are.¹ This requires both establishing diagnostics for identifying separate ingredients of meaning and characterizing their properties, including their source and status. As such, this enterprise is right at the nexus of semantics and pragmatics: many crucial issues relate to the question of whether a given piece of meaning is encoded conventionally or has its source in reasoning about the use of specific expressions, potentially based at least in part on more domain general resources not specific to linguistic knowledge.

The traditional starting point involves distinctions between conventionally encoded truth-conditional meaning, conversational implicatures, conventional implicatures, and presuppositions, following seminal work by Strawson (1950) and Grice (1975), among others. But many current debates are concerned with the potential need to refine these distinctions or redraw the lines between aspects of meaning. While this has given rise to various important and novel theoretical approaches, the crucial development for present purposes is that, in recent years, researchers have increasingly turned to experimental methods from psycholinguistics to shed light on theoretical questions in this area, both to obtain solid data on subtle phenomena and theoretical predictions that are hard to assess through introspection and to understand how abstract characterizations of linguistic knowledge relate to real-time cognitive processes in language comprehension. The current chapter surveys what has been achieved in this regard

¹This content of this chapter draws extensively on previous overview papers, in particular Schwarz (2015a, 2016a), though in reorganized form. The summaries of experimental work in section 2, section 3, and section 4.1 in particular have largely been adapted from sections 2 and 3 of Schwarz (2016a).

in the study of presuppositions in particular, both in terms of methodological developments and the theoretical implications of experimental results.

Presuppositions convey information that is typically assumed to already be taken for granted by the discourse participants. Furthermore, they are characteristically unaffected by a variety of linguistic embedding environments, such as negation, conditionals, and questions. Given this direct relation to the discourse context as well as the interaction with their intra-sentential linguistic environment, presuppositions provide a particularly useful perspective on the interplay of linguistic and domain-general processes in language comprehension.

The chapter is structured as follows: the remainder of this section introduces some basic background and provides a sketch of key issues in the current literature. These concern debates about the semantic vs. pragmatic nature of presuppositions and their interaction with context, as well as the potential need for distinguishing sub-classes of presupposition triggers. Next, we turn to experimental approaches to investigating presuppositions experimentally, beginning with triggers in simple, non-embedded linguistic contexts and their relation to the discourse context. Section 3 turns to issues relating to ‘projection’ phenomena for triggers in embedded contexts. In section 4, we review recent developments concerning the relation between presuppositions and more elaborated aspects of the discourse context. Section 5 concludes and provides an outlook on future directions for the field.

1.1 Basic Phenomena

The modern notion of presupposition traces back to Frege (1892), who considered the existence of an entity with the property of a noun phrase within a definite description a ‘Voraussetzung’, i.e. a pre-condition or presupposition for the sentence containing the expression to be meaningful. While definites gained further importance through the famous debate between Russell (1905) and Strawson (1950, see Reimer & Bezuidenhout 2004 for a collection of recent contributions on the topic), the literature on the topic soon recognized that the key phenomena were paralleled by a host of other expressions (Karttunen, 1973, 1974; Stalnaker, 1973, 1974), e.g. factive verbs (e.g., *know*), aspectual verbs (e.g., *stop* and *continue*), iteratives (e.g. *again* and *too*), and clefts. In particular, all of these expressions contribute something to the overall meaning that is backgrounded and, at least in many cases, taken for granted by the discourse participants already. Consider the following examples.

- (1) a. Sue invited John again.
- b. Mary has stopped throwing parties.
- c. It was James who sent Anna the invitation.

The main point (commonly also referred to as ‘at-issue’ or ‘proffered’ content) of (1a) would seem to be that Sue invited John, whereas the information introduced by *again*, that she had done so previously, is backgrounded, or presupposed. Similarly, the main point of (1b) is that Mary doesn’t throw parties

at present, whereas the notion that she used to do so in the past is presupposed. Finally, the cleft construction typically is associated with an existential presupposition to the effect that the relative clause property holds of some individual; the main point, of course, is that James is the culprit in the present case (see Onea, this volume, for more details).

The backgrounded nature of presuppositions is reflected in various other empirical facets. First, there is a common perception, going back to Frege's and Strawson's discussions of definite descriptions, that sentences whose presupposition is not met are neither true nor false, i.e., they can't straightforwardly be assigned a truth-value in intuitive terms. To illustrate, ask yourself whether (1b) is true or false if considered in a context where it is known that Mary has never thrown a single party.

Another related property of presuppositions is that they cannot generally be used to introduce new information. For example, it would be decidedly odd (and certainly seem highly presumptuous) if I casually uttered (2) in conversation; similarly, (3) does not make for a good way of breaking the news of one's engagement to one's parents.

- (2) President Obama called me again last night.
- (3) I'm going to Hawaii with my fiance next week.

A common reaction to such pronouncement might well start with 'Hey, wait a minute, I didn't know that...' (see von Stechow, 2008, for discussion of the 'Hey, wait a minute test', inspired by Shannon 1976), reflecting the sense that crucial and important information has been introduced in an inappropriate, underhanded way. But while it often seems impossible, or infelicitous, to use presupposed material to introduce new information, there are plenty of cases where this seems perfectly natural. Following Lewis (1979), these are thought to be cases of 'accommodation', which is typically seen as a type of repair mechanism (see von Stechow, 2008, for detailed recent discussion). For example, I can easily utter (4) to someone that I just met, and who doesn't know anything about my home life:

- (4) I'm sorry I'm late, I had to take my cat to the vet.

The notion that I have a cat is standardly assumed to be introduced as a presupposition here, by virtue of the possessive description *my cat*; and yet, despite being completely new information, there is no sense of anything going wrong by treating this information as 'taken for granted'. But note that various details, such as the fact that having cats as pets is common and that I should be an authority on what pets I have, play an important role (change *cat* to *elephant*, and this becomes much harder to swallow). Various intricate issues arise in trying to flesh out the factors at play. For recent discussions, see Beaver (2001), Simons (2003), von Stechow (2008), and Beaver & Zeevat (2012).

The fact that presuppositions are not part of the main point of the utterance also shines through when considering simple denial responses: responding *No* (, *that's not true!*) to any of the above examples will generally challenge the

truth of the main point (Obama having called me last night, going to Hawaii, having gone to the vet), but typically not question the presupposed information - doing so requires more elaborate replies (*Wait, that can't be true - you don't even have a cat!*).

The point about presuppositions not being the target of denials has a much more general correlate in sentences where presupposition triggers appear in the scope of embedding operators, which is commonly taken to be another (if not THE!) hallmark feature of presuppositions. In a wide range of such embedding environments which prevent the main at-issue content from contributing to the conveyed content at the matrix level, presupposition-based inferences remain intact, i.e., they appear to not be affected by the embedding - a phenomenon commonly referred to as 'presupposition projection' (Langendoen & Savin, 1971; Karttunen, 1973, 1974). The following selection from the 'family of sentences' from Chierchia & McConnell-Ginet (1990) illustrate this (see their discussion for the full set of environments):

- (5) a. Sue didn't invite John again.
- b. Did Mary stop throwing parties?
- c. If it was James who sent Anna the invitation, then he should sit next to her.

Negation, questions, and conditionals are environments where the at-issue content of the clauses in question no longer is conveyed by the utterance as a whole: we would not conclude from these sentences that Sue invited John this time around, that Mary doesn't throw parties at present, or that James sent Anna the invitation. These pieces of information are precisely what is negated, questioned, and considered as a candidate state of affairs respectively. But the presuppositions (that Sue invited John before, that Mary used to throw parties, that someone invited Anna) remain untouched as part of the overall meaning, i.e., they are seemingly unaffected by the embedding altogether. However, things are more complex than that, as there are other cases where the perceived global presence of the relevant inferences depends on other content within the sentence:

- (6) a. If Sue is hosting the party, then it was James who sent Anna the invitation.
- b. If Anna received an invitation by mail, then it was James who sent her the invitation. (He's the only one who knows her physical address!)

While the presupposition that someone invited Anna is clearly present for the sentence as a whole in (6a), this is not so for (6b), presumably because of the content of the antecedent clause, which is the only part changed from (6a), and which clearly bears on the issue of whether or not someone sent her an invitation. The problem of explaining the interaction of embedded presuppositions with their linguistic context has constituted one of the core challenges in the theoretical literature, and we will briefly review some of the main approaches below.

1.2 Semantics vs. Pragmatics and Explanatory Challenges

To capture the empirical phenomena concerning presuppositions that were sketched above, a classical truth-conditional approach to linguistic meaning (as laid out, e.g., in Heim & Kratzer, 1998) has to be enriched to allow for the separation of different components of meaning in one way or another. This can be done either by handling presuppositions at a pragmatic level, or by amending the semantics. Some of the earliest approaches (based on Kleene, 1952) chose the latter route, by supplementing accounts based on classical logic with a third truth-value (standardly labeled ‘#’) to represent the status of sentences whose presupposition is not met as being neither true nor false (for recent proposals in this tradition, see Beaver & Krahmer, 2001; Fox, 2008; George, 2008b, as well as supervaluation-based variants, going back to van Fraassen 1968).²

An alternative pragmatic approach was first offered by Stalnaker (1973, 1974), which is based on the notion of the Common Ground that represents beliefs mutually held by the discourse participants for the purposes of conversation. The point of assertions is to add information to the Common Ground, while the role of presuppositions is to indicate that the presupposed information already is in the Common Ground. If it is not, the context update fails (which mirrors the third truth-value of semantic approaches). While this notion of presupposition is fundamentally pragmatic - speakers of utterances, rather than sentences, presuppose - Stalnaker leaves open the possibility that certain expressions could nonetheless be conventionally associated with presuppositional uses (see also the notion of ‘Stalnaker’s Bridge’ in von Stechow, 2008, as well as further discussions below on the issue of how presuppositions come to be).

Influential work by Heim (1982, 1983) initiated the enterprise of dynamic semantics, which provides an integrated perspective on intra-sentential semantics and the discourse context, effectively incorporating Stalnaker’s approach of modeling the contribution of (utterances of) sentences in terms of their impact on the discourse context. On this view, the semantics of sentences is characterized as their context change potential (which can be straightforwardly related back to more standard truth-conditional characterizations). Presuppositions can then be seen as conventionally encoded constraints on the types of contexts for which a given expression allows updates. A similar approach was also developed within Discourse Representation Theory (DRT; Kamp 1981; van der Sandt 1992), which provides a representational framework for modeling the discourse context. Presuppositions here are seen as a type of anaphora that directly links back to information already present in the existing discourse representation structure (DRS).

While for some time, dynamic approaches dominated the discussion and were assumed to be successful in particular because of their successful account of (at least the majority of) projection phenomena, recent years have seen a revival of various alternative approaches. The chief motivation have been challenges to the explanatory adequacy of standard dynamic accounts. The remainder

²Parallel formal options also have been explored in the study of Vagueness (Alxatib and Sauerland, this volume); see Zehr (2015) for a unified approach to the two phenomena.

of this section turns both to these issues and a brief sketch of the alternative paths pursued in the literature to meet the newly raised challenges. The two fundamental questions raised in this debate are a) Where do presuppositions come from? (the Triggering Problem) and b) Why do presuppositions exhibit their characteristic projection behavior?

1.2.1 The Triggering Problem

On purely semantic accounts of presuppositions, they form part of the conventionally encoded meaning of the expression in question. Such accounts are therefore not particularly concerned with the question of where presuppositions come from. Typically, they content themselves with being able to diagnose a given piece of meaning as presuppositional in virtue of its projection behavior, and then posit it as part of the lexically encoded meaning. Accounting for the projection behavior is then seen as the key challenge. But a case can be made that simply positing presuppositions as part of lexical entries falls short of the explanatory adequacy we should strive for. How come, one might ask for example, that we find correlates of so many presupposition triggers across languages without any variation in what is presupposed and what is asserted. Take *stop* and *start*, which seem to have straightforward correlates across many, if not all, languages: they all presuppose the preceding state or activity and assert what is happening now. This hardly can be a coincidence, but simply stipulating the presupposition of *stop*, *start*, and their correlates in their lexical entries fails to explain this apparent uniformity.

Various pragmatic approaches share the central goal of meeting this challenge in explanatory adequacy, at least for a sub-class of triggers, starting with remarks by Stalnaker (1974, for a more extensive review of these accounts, see section 2 of Abrusán 2011, which the present discussion follows loosely). The general idea is that triggers such as *stop* and *know* respectively come with distinct entailments (e.g., that x used to V and that x V 's now; that x believes p and that p is true), and that, in Stalnaker's words, a speaker 'would be *leaving unclear whether his main point was* to make a claim about' one or the other of these entailments. The challenge then is to provide a systematic account of how one of these entailments winds up as backgrounded or presupposed, without alluding to any conventional encoding of such notions. Sperber & Wilson (1979) attempt to do so in terms of focus; more recently, Simons (2001) proposes that the truth of a proposition q winds up as presupposed when an utterance raises the question *Whether p* and p asymmetrically entails q . Abusch (2002, 2010) bases her account on the notion that presupposition triggers are associated with alternatives (see Skordos and Barner, this volume), and that presuppositionality results from reasoning over these alternatives (for a similar approach, based on different assumptions about alternatives, see Romoli, 2014).

Simons et al. (2010) put forth a more general novel approach to 'projective meaning' (including conventional implicatures), which relates presuppositionality directly to at-issueness in terms of the relation of content to the Question Under Discussion (QUD; Roberts 1996). Finally, the most recent approach has

been laid out by Abrusán (2011, 2016), who frames the foreground-background distinction in terms of general principles of attention. All of these proposals face substantial challenges (again, see section 2 of Abrusán, 2011, for a brief review) or are still in active development, so the jury is still out on what line of attack proves to be most successful, if any. Also note that, in principle, semantic approaches positing conventional encoding of presuppositions could be reconciled with certain versions of these approaches by grounding the conventional encoding as the result of pragmatic pressures leaving an impact over time, i.e., seeing conventionalized presuppositions as fossilized versions of ever-present pragmatic forces (there is little work pursuing a historical perspective on presuppositions, but see Beck & Gergel, 2015, for a recent example).

For present purposes, one particularly important aspect of this debate consists of the fact that many of the pragmatic approaches liken the process by which a presupposition (or the presuppositional nature of a given proposition) is derived to other pragmatic inferences, in particular conversational implicatures. These, in turn, have been the focus of the first major wave of research in Experimental Pragmatics (see Breheny, this volume), which opens up a variety of avenues for exploring potential predictions of presupposition theories experimentally. These will be discussed in the following sections.

1.2.2 The Projection Problem

As already noted, explaining presupposition projection patterns has long been taken to be the main challenge for a theory of presuppositions. Just like in the case of the triggering problem, there are proposals on both sides of the semantics-pragmatics divide. Once more, Stalnaker's seminal work provided the starting point for grounding projection phenomena in the dynamics of linguistic interaction. To illustrate, take another variation on a pair of complex sentences where the presupposition in the second clause acts differently:

- (7) a. Sue is hosting the party and it was James who sent Anna the invitation.
- b. Anna received an invitation by mail and it was James who sent her the invitation.

Stalnaker's proposal boils down to the idea that when assessing the second conjunct here, the relevant context is that established by adding the first conjunct to the common ground. This makes makes all the difference given the initial conjuncts: in (7a), Sue hosting in no way addresses the issue of whether someone sent Anna an invitation. Therefore, this presupposed proposition has to be met by the global context, as reflected in the intuitive sense that the sentence as a whole is associated with the presupposition. In contrast, the first conjunct in (7b) entails that someone sent Anna an invitation, and thus it is guaranteed, no matter what the global context is, that the presupposition of the second conjunct is met.

Stalnaker sketches the general direction of how this approach can be extended to other embedding environments. But this was made much more con-

crete by dynamic semantic approaches, which take the same general perspective on context change but incorporate it directly into the semantics. This is straightforward for conjunction, but also extends to other operators. For example, for conditionals (assuming a material implication analysis for simplicity), context update involves removing those worlds from the initial context where the antecedent is true and the consequent is false. Technically speaking, updating a context c with a conditional *If p then q* proceeds as follows:³

$$(8) \quad c + (\text{If } p, \text{ then } q) = c - ((c + p) - ((c + p) + q))$$

Crucially, the consequent q is interpreted relative to the original context updated with the antecedent $(c + p)$, rather than just the original context c alone. This makes the account of the fact that (6a) imposes no constraints on c entirely parallel to the conjunction case above: $c + p$ is a subset of p (and thus entails the presupposition of q , that someone invited Anna), and it is thus ensured that update with q cannot fail.⁴

While dynamic semantic approaches enjoyed the status of being the standard and were essentially seen as a successful solution to the projection problem, they face an explanatory challenge that was first raised by Mats Rooth (in a letter to Irene Heim) and Soames (1989, also discussed by Heim 1990), and gained prominence through recent discussion by Schlenker (2008a, 2009). In a nutshell, there is no inherent theoretical reason why the various operators should map onto context updates that reflect the linear order in the sentences. For example, nothing prevents an alternative formulation of context change potentials, say for conjunction, that reverses that order:

- (9) a. Usual context change potential for conjunction:
 $c + p \text{ AND } q = (c + p) + q$
 b. Alternative context change potential for conjunction:
 $c + p \text{ AND } q = (c + q) + p$

While the usual version successfully captures the projection phenomena in (7a) and (7b) above, the theoretically possible alternative version in (9b) would make different predictions, namely that projection should operate on the reverse of the linear order.⁵ Clearly, lexical entries corresponding to these alternatives are not attested in any language, but, the explanatory challenge goes, dynamic semantics has no explanation to offer for this.

³‘+’ represents the operation of context update, which in the simplest case amounts to set-theoretic intersection of propositions construed as sets of possible worlds. Similarly, ‘-’ stands for the set-theoretic difference.

⁴DRT offers an alternative dynamic approach that is largely parallel in empirical coverage, though with some differences which also relate to experimental results discussed in section 4.1.

⁵There are other potential alternatives, e.g.

- i. $c + p \text{ AND } q = c + (p + q)$

which would also make different predictions in terms of whether the context c and the first conjunct can jointly conspire to ensure the presupposition of the second conjunct.

One highly influential response to this problem has been developed by Philippe Schlenker, in various versions (Schlenker, 2008a, 2009, 2010b, for an introductory overview, see Schlenker 2011). The basic move boils down to combining a classical, non-dynamic semantics with Stalnaker’s pragmatic approach to projection, while maintaining the predictions of a Heim-style dynamic semantics. In doing so, the explanatory challenge is resolved through an appeal to the role of the incremental unfolding of spoken language in comprehension. At the same time, the full generality of the system in terms of coverage of operators (as well as quantifiers) that Heim’s system achieved is maintained. While Schlenker’s account is based on a specific, formalized notion of Local Contexts, resting on an idea of efficient interpretation where only possibilities that are crucial are considered along the way, there are various other similar approaches couched in multi-valent semantic systems (Kleene, 1952; Peters, 1979; Beaver & Krahmer, 2001; Fox, 2008, 2012b; George, 2008a,b). Trivalent approaches provide interpretations for connectives via non-classical truth-tables. The Strong Kleene version of such a truth table (Kleene, 1952) posits that a complex sentence gets the value ‘#’ just in case one of its atomic sentences has that value and the truth values of the other atomic statements do not suffice to determine the truth value of the entire sentence based on standard logic (for a recent account, see Beaver & Krahmer, 2001, and Beaver & Geurts 2012 for an overview). This captures projection phenomena, as can be illustrated for (6a) and (6b): the latter will always receive a classical truth-value, because (assuming a material implication analysis) if the antecedent is false, the entire conditional will necessarily be true, regardless of whether the presupposition is met or not. If the antecedent is true, on the other hand, then the presupposition is also true, since the antecedent entails it. Conversely, for (6a), there is no such relationship between the antecedent and the consequent, and thus it’s possible for the entire sentence to receive the value ‘#’ if the presupposition of the consequent is not met.

The main novel feature of these recently developed accounts is that they offer a modular perspective that can separate out the semantic machinery underlying projection from pragmatic principles crucially driven by the left-to-right properties of actual comprehension. In particular, these can be thought of as a semantic component that is independent of linear order on the one hand, and a processing-driven preference for calculating presuppositions on the fly with order-based, incremental effects on the other. This allows for a principled explanation of the asymmetries stipulated by dynamic semantics, while leaving open the possibility that symmetric interpretations are available as a dispreferred alternative. It also opens up interesting questions about presupposition processing, as will be discussed below.

The final recent approach to mention here is the QUD-based approach represented by Simons et al. (2010, and related work). As noted above, it relates presuppositionality directly to at-issueness, which in turn is explicated in terms of relevance to the QUD. Projection is also explained in these very terms, by positing that it is precisely the content that is not at-issue that projects. Key features of this account are a) that the projective nature of a given piece of content can interact directly with the discourse context; b) that there is no

need for semantic machinery that deals with projection; and c) that the triggering problem and the projection problem are grounded in the same property, not-at-issueness. This perspective on presuppositions also opens up interesting questions for experimental investigation, though first steps towards their exploration have only been taken recently.

In addition to projection from sentential operators, intricate issues also arise when presuppositions appear in the scope of quantificational expressions, as in (10):

- (10) Most semanticists headed to the bar again after the talk was over.

Descriptively speaking, we can differentiate three types of theories: a) universal theories, which predict that regardless of quantifier, the presupposition has to hold of all the individuals in the domain quantified over, i.e., that all semanticists are presupposed to have been to the bar before (Heim, 1983; Schlenker, 2008b, 2010a; Chemla & Schlenker, 2012; Mayr & Sauerland, 2016, also see George 2008b; Fox 2012a for slightly weakened variants); b) existential theories, which uniformly predict that this presupposition merely needs to hold of *some* individuals in the domain (Beaver 1994; van der Sandt 1992; Geurts 1998); c) mixed theories of various sorts, e.g., ones that assume that either reading is generally available or that the quantificational force at play in the presupposition varies across different quantifiers (Chierchia, 1995, 2010; Chemla, 2009a; Romoli, 2012, 2014; George, 2008b; Sudo, 2012; Mandelkern, 2016; Mayr & Sauerland, 2016). While we cannot go into the details of how these predictions are derived formally on the various accounts for reasons of space, the empirical question of which readings are actually available and how they are derived constitutes another important area for experimental work, to which we turn in section 3.1.1.

1.3 Distinguishing Types of Presupposition Triggers

An additional theoretical development, which at least in part has gone hand-in-hand with attempts to explain the triggering problem, concerns proposals to distinguish different types of presupposition triggers. In particular, various of the proposals for analyzing ‘soft triggers’ in terms of conversational reasoning alluded to above (e.g. Simons, 2001; Abusch, 2002, 2010; Romoli, 2014) draw a distinction in terms of the source of the presuppositions of various triggers, as their pragmatic account only applies to a sub-class of triggers, namely the ‘soft’ ones. The ‘hard’ triggers, such as *too* and *again*, are usually assumed to involve lexically encoded, conventional presuppositions.

But various other proposals for potential distinctions between triggers exist in the literature as well, which focus more on how different triggers relate to the context. Kripke (2009, originally published in 1990) noted early on that some triggers are much more susceptible to accommodation than others, which he tries to capture in terms of whether or not they are anaphoric, i.e., require an antecedent in the discourse context (in a manner quite parallel to pronouns;

see Rohde, this volume). Similarly, Zeevat (1992) distinguished ‘lexical’ from ‘resolution’ triggers, where the former involve a presupposition that’s directly related to the main asserted content (e.g., *know*) and the latter are anaphoric (e.g., *too*). Glanzberg (2005) argues for yet another related distinction between ‘weak’ and ‘strong’ presupposition triggers, based on observations about whether they are associated with obligatory or optional accommodation, the main idea being that in the latter case, context update with the asserted content is possible even when the presupposition is not met, e.g., in the case of sentences containing the triggers *again* or *too*, whose presupposition is highly independent of the main asserted content.

In another line of work, Sudo (2012, also see Sudo & Spathas 2015) and Klinedinst (2012) take another approach by differentiating triggers in terms of how the presupposition relates to the entailed content: the presupposed content of some triggers, they suggest, such as *stop*, has a dual presence in the lexical representation, so that they are part of both the presupposed and the entailed content (for a related idea within an analysis of NPIs in definite descriptions, see Gajewski, 2016; Gajewski & Hsieh, 2014).

Finally, Tonhauser et al. (2013) provide a classification of ‘projective content’ that is both broader in scope and more fine-grained than a traditional view. In particular, amongst expressions that are classically considered to be presupposition triggers, they differentiate whether a given trigger has ‘obligatory local effects’ (i.e., contributes to the compositional interpretation of its clause, even when embedded; this is parallel to Zeevat’s notion of ‘lexical’ triggers as well as to Sudo and Klinedinst’s notion of presuppositions being entailed). Furthermore, they divide triggers based on whether they come with a strong contextual requirement, which roughly corresponds to whether or not (or how easily) their presupposition can be accommodated. Combining these two distinctions, they propose a system of 4 types of projecting content (where content with neither a local effect nor a strong contextual effect roughly corresponds to the notion of conventional implicatures in the sense of Potts 2005).

As will be seen below, these discussions about differentiations between triggers have played an important role in much of the experimental work, as the various proposals inherently come with empirical criteria for distinguishing types of triggers, which in turn can straightforwardly be investigated more systematically with experimental tools.

2 Presupposition Interpretation in Experimental Tasks

In this section, we turn to experimental work on presuppositions and its relation to the theoretical issues discussed above. We begin by considering issues arising for presuppositions in unembedded environments, and turn to questions specific to embedded environments in the following section. From an experimentalist’s perspective, there are a number of questions to ask about the role

of presupposed content in language comprehension,⁶ each of which in turn can be addressed using a variety of methodological approaches. The following discussion is organized by these questions, in particular:⁷ Is a given putative presupposition indeed at play in experimental settings? (section 2.1) What reflexes does the arguably special status of presuppositions have in behavioral measures? (section 2.2) What happens when a trigger is used in a context where its presupposition is not already established? (section 2.3) What is the time-course of presupposed content becoming active in online comprehension (both in absolute terms and relative to other aspects of meaning)? (section 2.4) In the course of discussing these questions, the core methodological approaches used for studying presuppositions to date will also be introduced. Furthermore, the crucial theoretical issue of whether there are different sub-classes of triggers will pop up throughout (a discussion of this issue in its own right will be postponed until section 3.3, as the most crucial contrasts relate to how different triggers behave in embedded environments).

2.1 Detecting Presuppositions Experimentally

The perhaps most fundamental empirical question about a given expression that is assumed to be associated with a presupposition is whether the presupposition is indeed present. This question has at least two parts: first, is the content in question associated with the expression, and secondly, does it have the properties we expect presuppositions to have? We begin by considering two studies exemplifying methodological attempts to address the first question. Much of what follows in later sections will naturally bear on this as well, but also inform the second question. In addition to empirically confirming theoretical assumptions about the impact of triggers on meaning, basic methodological questions are also at stake: given that the prevalent theoretical views see an inherent relation of presuppositions to the discourse context, it cannot simply be assumed that presuppositions will arise in their usual way in abstract experimental settings, which often involve the presentation of isolated sentences by an unknown speaker (or writer). Thus, it is methodologically crucial to ensure that presuppositions play their usual role in such settings.

One approach to testing for the presence of a given piece of content in a sentence is to provide multiple paraphrases and ask participants to select the one that best corresponds to their interpretation of the sentence. Schwarz (2007) used precisely such a task to investigate syntactically ambiguous German sentences, whose structural ambiguity interacted directly with the presupposition of the trigger *auch* ('also'). The ambiguity was created based on syncretism for N(ominative) and A(ccusative) case marking in German, as in the following:

- (11) Die Frau, die das Mädchen sah, hatte auch der Mann
 The woman_{N/A} who_{N/A} the girl_{N/A} saw had also the man_N

⁶In principle, there are equally interesting and important questions about production, but to my knowledge, these have not been approached experimentally.

⁷For a presentation covering mostly the same ground but organized in terms of methodological approaches, see Schwarz (2016a).

gesehen.

seen

‘The woman that (saw the girl/ the girl saw) had also been seen by the man.’

Subjects had to select one amongst various paraphrases, which differed in whether the woman was said to have seen the girl or vice versa. Based on syntactic processing preferences, the former is independently preferred. However, the other interpretation ensures that the presupposition introduced by *also* (that someone else had seen the woman) is satisfied. The results indicate that subjects indeed take this into consideration, as the paraphrase in line with the presupposition was chosen more frequently than in a presupposition-less control condition. This provides evidence that even in abstract experimental settings with sentences out of context, interpretation choices seem to be affected by a desire for interpretations that fully incorporate their presupposition, which may override independent processing factors biased in the opposite direction. Other variants of tasks aiming to directly identify whether a presupposition is part of the interpretation of a sentence target inferences in other ways, either by asking questions pertaining to the presupposed content (e.g. Tiemann, 2014; Tiemann et al., 2015; Domaneschi et al., 2013) or by directly asking participants whether they would draw the relevant inference when presented with the sentence (e.g. Chemla & Schlenker, 2012). These will be discussed in section 2.3 and section 3.1.2 respectively, as they bear on additional, more complex issues.

In addition to the paraphrase selection study, Schwarz (2007) also presented reading time evidence supporting the notion that the presupposition is active in comprehension within the experimental setting. This consisted of self-paced reading results for both German and English on disambiguated versions of the sentences, where the presupposition is either met or not supported within the presented sentence. Reading times increased significantly on the region containing *also* in the latter case. Along the same lines, Tiemann et al. (2011) report self-paced reading results for various triggers as well, with parallel slow-downs either on the region containing the trigger or the one following it (see Tiemann, 2014, for additional results on *again*).

Another reading time study, by Clifton (2013), further enriches the methodological perspective and reinforces the point that it should not be taken for granted that presupposition-based effects always arise in experimental setups. He looks at definite descriptions, focusing on the effect of the uniqueness presupposition. A context sentence is used to establish whether there is one or multiple of the relevant items (e.g., *In the kitchen...* vs. *In the appliance store...*), and the following target sentence contained either a definite or an indefinite description (*{The / A} stove*). Despite clear intuitions about the variation in the felicity of the materials, Clifton found no slow-down effect in an initial self-paced reading study, in contrast to the previously mentioned studies. However, a follow-up with memory load in form of a simple arithmetic task added in between reading the sentence and answering a comprehension question found a clear effect in the region following the definite, with longer reading times in

the multiple-item (\approx non-uniqueness) condition. This highlights an important methodological aspect, namely that subjects may not fully engage in linguistic processing in an experimental setting when the task at hand does not require it.

A different, and in some ways more straightforward, approach to testing for the presence of presuppositions in the interpretation of a sentence is to use tasks where the presence or absence of the potential presuppositional inference in question will be revealed indirectly through subjects' behavior in a non-linguistic task. One methodologically quite ingenious implementation along these lines can be found in the acquisition study by Dudley et al. (2015), which investigates the factive presupposition of attitude predicates such as *know*. A crucial question for them is to what extent children are sensitive to this aspect of meaning, specifically in contrast to non-factive verbs such as *think*. Dudley et al. (2015) address this question through a guessing game, where an experimenter hid a toy in one of several boxes. Before the child guessed which box contained the toy, a puppet would whisper in the experimenter's ear. The experimenter would then relay what the puppet said by saying *Lambchop (doesn't) {know / think} that it's in the red box*. If children are aware of the factivity of *know*, their response behavior for the two verbs should differ. Dudley et al.'s (2015) results show that at least some of the 3-year olds in their study have an exquisite understanding of the factive component of *know* (on par with expected adult behavior). This extends not only to the truth of the complement of *know*, but also to its core presuppositional property of projecting out of the scope of negation.

Studies such as the ones exemplified here constitute a methodological proof of concept that presuppositions can be fruitfully investigated experimentally, and thus open up a wide range of possibilities for investigating further aspects of presuppositions. The next section turns to the status of presuppositions in comparison to asserted content.

2.2 Reflexes of the Status of Presuppositions

A crucial aspect of distinctions drawn between presupposed content and other aspects of meaning, chiefly the conventionally encoded, truth-conditional content that forms the core of what's asserted, is that they differ in status. This can affect a variety of behavioral measures, from truth value judgments to response times and available continuations or responses to presuppositional sentences. Given the historical role of definites in the study of presuppositions, let us begin with the standard claim that non-referring definites lead to a sense of 'squeamishness' (Strawson, 1950), i.e., reluctance to judge them to be either true or false. Abrusán & Szendrői (2013) utilized a truth value judgment task in which they provided a third option labeled as 'can't say'. Their materials included a number of variations in terms of the role of the definite in the sentence, based on notions such as topicality and verifiability, which have been argued to affect the strength and/or presence of squeamishness in the literature (Reinhart, 1981; Lasersohn, 1993; von Stechow, 2004), as well as negated

versions. Somewhat surprisingly, affirmative sentences were found to be judged as ‘false’ quite consistently by subjects, with little use of the ‘can’t say’ option, suggesting that either there is no relevant difference in status attached to the existential implication, or that this task is not sensitive to it. However, the negated versions of their sentences displayed significant variation in the distribution of judgments, which suggests that the existence condition of definite descriptions does indeed have a status distinct from basic entailments, whose impact on judgments can furthermore be modulated by a variety of pragmatic effects. More recently Zehr (2015) reports a similar study presenting sentences with the presupposition trigger *stop* paired with visual contexts. In this study, the third choice is introduced as ‘neither’, which subjects choose about 50% of the time, suggesting that squeamishness can indeed be captured for affirmative sentences in truth-value judgment tasks with additional response options.

Since truth value judgment tasks do not always provide straightforward evidence for such a distinction, other studies have taken the approach of looking at the time course of truth value judgments to assess whether false-judgments based on false asserted vs. false presupposed content might be differentiated in terms of their time course. First, Kim (2007) investigated the presupposition of *only*. A sentence like *Only the girls have books* commonly is taken to presuppose that the girls have books. Kim’s experiments present such sentences in visual contexts that either did or did not conform to this presupposition (i.e., showed the girls as having books or not). The truth of the asserted content (whether or not non-girls had books) was also varied across conditions. Subjects took longer in their responses when they were based on an unmet presupposition than when they were based on false asserted content. Kim interprets this result as a reflex of the backgrounded nature of presuppositions, which impacts the verification procedure employed in the task: presuppositions are literally taken for granted, and not initially verified, in contrast to asserted content, which leads to longer reaction times in falsifying them. Schwarz (2016b) takes a similar approach to the study of the existence implication of definite descriptions, again by asking subjects to provide truth value judgments on sentences relative to visual contexts which either falsify the asserted or the presupposed content. Indefinites serve as a control, where essentially the same information is asserted in both conditions. The results yield a significant interaction between type of determiner and the contextual information affecting which part of the sentence is falsified. This suggests that the status of the existence implication is indeed distinct from that of the main asserted content, and thus supports presuppositional analyses of definites in the tradition of Frege (1892) and Strawson (1950), in contrast to accounts in the tradition of Russell (1905), which see it as a mere entailment.

Another set of tasks that has proven useful in investigating presuppositions involves comparisons between different versions of continuations of a presuppositional sentence. Onea & Beaver (2011) and Destruel et al. (2015) used this to investigate the exhaustive inference of focus and clefts (Onea, this volume; also see Velleman et al., 2011, for other triggers). Example (12), from Destruel et al. (2015), illustrates a forced choice version of the task, where subjects had to

indicate which of several continuations, including the ones below, best matched the context:

- (12) It was a necklace that Phillip bought his sister.
- a. Yes, but Phillip also bought his sister a bracelet.
 - b. No, Phillip also bought his sister a bracelet.

For clefts, as compared to exclusive statements with *only*, subjects more frequently selected continuations like the one in (12a). The authors explain the difference between clefts and exclusives in terms of the status of the exhaustive inference, which is at-issue in the latter but not in the former, and thus is more or less likely to be targeted by *Yes* and *No*.

Other studies use an acceptability rating version of this approach. Cummins et al. (2013) and Amaral & Cummins (2015) investigate various triggers in English and Spanish and test the acceptability of *Yes*, *although...* and *No*, *because* continuations:

- (13) Q: Did Brian lose his wallet again?
A: Yes, although he never lost it before.
A': No, because he never lost it before.

Across all triggers, both responses are degraded relative to controls, suggesting that contradicting the presupposition comes with a cost. But interestingly, the triggers in their results seem to be grouped into two classes, which the authors relate to the distinction between lexical and resolution triggers (Zeevat, 1992). Recall that the latter are anaphoric and directly relate back to entities (or events) in the context (e.g., *again* and *too*), while the former involve cases where the presupposition is a requirement that comes with the asserted component of the trigger (e.g., *regret*, *stop*, *still*, *continue*, *stop*). For lexical triggers, the authors find systematically higher acceptability ratings for continuations parallel to (13)A', whereas there is no difference in acceptability between the continuations for the resolution triggers. This is in line with Zeevat's distinction, as for these (and only for these), 'the responses in condition [A] appear self-contradictory, if we assume that the presupposition is a logical prerequisite for the at-issue content of the trigger' (p. 169 Amaral & Cummins, 2015).

2.3 'Novel' presuppositions: To ignore, accommodate, or cancel?

As noted in section 1.1, presupposition triggers can be used in many circumstances where their presupposition is not already established, despite the common view that they impose felicity requirements on the context. Such cases are usually assumed to involve accommodation, a repair process in which hearers quietly accept the presupposition, leading them to adjust the common ground to entail the presupposition in order to be able to interpret the sentence relative

to this adjusted context (Lewis, 1979; von Fintel, 2008). But other characterizations of such cases are in principle available. It might be that presuppositions are sometimes ignored altogether, or cast aside once it's clear the context doesn't support them (see, in particular, the proposal by Glanzberg, 2005, to which we return below). This section reviews experimental work contributing to our understanding of what happens when hearers encounter such 'novel' presuppositions.

In light of the view of accommodation as a repair mechanism, a fair share of work in this area has tried to determine whether there is any measurable cognitive cost involved. This is particularly pressing as it is indeed quite common, at least for a certain range of triggers (see Spender, 2002, for extensive corpus data illustrating this).

Methods of assessing the extent to which accommodation is available, and whether it is costly, include reading time measures and acceptability ratings in contexts that do not directly support the presupposition. Some early psycholinguistic studies investigated related issues based on definite descriptions, especially cases of *bridging* (Clark, 1975). For example, Haviland & Clark (1974) compared contexts that required a bridging inference (e.g., mentioning picnic supplies) with ones where some entity (e.g., beer) was mentioned explicitly, and found longer reading times on a subsequent presentation of a definite (e.g., *the beer*). O'Brien et al. (1988) showed, however, that prior mention of a referent is not necessary if the context is sufficiently specific: the definite *the knife* was read more slowly when the antecedent was more general (*a weapon*) than when it directly matched the noun phrase (*a knife*), but only when the context involved a general verb such as *assault*, and not when it involved *stab*, which is more closely associated with knives. In an acceptability rating study, Carlson & Tanenhaus (1988) find that a sentence like *The suitcases were heavy* is judged to make sense more frequently following the sentence *Bill hurried to catch his plane* than the sentence *Bill hurried to unload his car*, presumably because the presence of suitcases is more salient in the former case. A more recent set of studies illustrates how fleeting accommodation-based effects for definites can be. Frazier (2006) looks at the impact of plausibility on accommodation, e.g., by varying the noun phrase occurring in a definite, using passive context sentence (*My order was taken*) followed by a plausible or implausible definite or indefinite (*a/the waiter/busboy*), and only found effects of plausibility, not of definiteness, in a reading time study. Another line of work has used neurolinguistic measures. For example Burkhardt (2006, among others; also see van Berkum et al. 2003 and subsequent work) used ERP-studies to identify neural correlates of bridging by looking at definites such as *the conductor* in contexts with an explicit antecedent, a bridging antecedent (*a concert*), and no antecedent. Intriguingly, the bridged cases display neural hallmarks of both new and old information in the form of a reduced N400 effect, followed by a P600 effect.

In the more recent literature, one rather comprehensive set of studies involving acceptability measures comes from (Tiemann et al., 2011). These authors look at contexts with varying degrees of support for a variety of German presupposition triggers, including possessives, factives, iteratives, and aspectual verbs.

For all these triggers, the use of presupposition triggers in contexts that do not explicitly support the presupposition is rated as less acceptable than both non-presuppositional controls and variations with contexts that support the presupposition. At the same time, they are rated consistently as more acceptable than variants where the context is directly inconsistent with the presupposition (also see Schwarz & Tiemann, 2012). This suggests that while there is some cost associated with accommodation, the associated decrease in acceptability is only a moderate one.

While Tiemann et al. (2011) find the same overall pattern for the various triggers in their study, the strength of the accommodation effect appears to be somewhat varied. This comes as no surprise, as it is commonly claimed that triggers differ substantially in their ease of accommodation, although it is by no means clear how to account for this theoretically (Beaver & Zeevat, 2007). As noted in section 1.3, Kripke (1991) claimed that triggers like *too* resist accommodation altogether. However, Tiemann et al.'s (2011) intermediate acceptability findings for *auch*, 'too' (as well as for *wieder*, 'again') indicate that accommodation is better than baseline controls with completely implausible adverbs or contexts that directly conflict with the presupposition. This is in line with observations by von Stechow (2008) and Chemla & Schlenker (2012) that accommodating *too* is possible when in line with plausibility in context. Singh et al. (2015) directly addressed this issue experimentally, using a stops-making-sense task, where subjects see a sentence unfold word by word as they press one button and are instructed to abort the trial with another button if it no longer makes sense to them. They compare the triggers *the* and *too* to presupposition-less controls in both plausible and implausible contexts, as in the following sentences:

- (14) Context: Bill went to {a club / the circus} on Friday night.
Target: {A / the} bouncer argued with him there for a while.
- (15) Context: John will go to {the pool / the mall} this morning.
Target: Peter will go swimming {tomorrow / too} after he gets back from school.

Rather strikingly, they find that in plausible contexts (... *a club* and ... *the pool*, respectively), the presence of the presupposition trigger has no impact on the stops-making-sense task, and subjects overwhelmingly accept the sentences for both triggers. In contrast, the presence of the trigger has a strong effect in implausible contexts, suggesting that accommodation is not viable. But in the plausible context, accommodation seems to be just as readily available for *the* and *too*. Reading time effects suggest that it may nonetheless be slightly harder in the case of *too*, but it is clearly not ruled out in plausible contexts.

In sum, acceptability rating tasks help to shed light on the relation of presupposition triggers to context. The results to date support the traditional notion that presuppositions in general impose constraints on felicitous contexts of utterance, but also suggest some need for distinctions between different types of triggers.

While acceptability rating and reading time measures help to assess the costs involved in encountering triggers in contexts that do not support their presupposition, they do not directly speak to the question of whether the presupposed content indeed does wind up getting added to the context. Several recent studies have addressed this point head-on using inference-based tasks, and argue their results to show that at least for certain triggers, the presupposition actually gets ignored, based on the notion that accommodation as a costly process is avoided whenever possible. Domaneschi et al. (2013) use comprehension questions for texts containing triggers to assess the presence of presupposition-based inferences. They auditorily presented short stories that contained a variety of presupposition triggers. The key measure came from a True/False comprehension question, which related directly to the presuppositions, none of which were explicitly supported in the story. (They also included a variation in cognitive load to assess processing efforts involved). The theoretical motivation was based on the distinction between triggers introduced by Glanzberg (2005), where triggers are assumed to differ in whether the presupposed information is obligatorily processed in non-supporting contexts (as with strong triggers such as factive verbs) or not (as with weak triggers, such as iteratives like *again*). Their results suggest that these two types of triggers indeed differ in terms of how present the information introduced by them is when answering questions about the previously heard text, in that accuracy is overall much lower for weak triggers. While these findings are in line with the distinction between strong and weak triggers, alternative explanations should also be explored, e.g., in terms of the level of backgroundedness or immediate relevance for the current topic of discussion when the trigger is encountered.

Another related inference-based task is incorporated into the study of *again* by Tiemann (2014) (also see Tiemann et al., 2015), with results that seem to mirror those by Domaneschi et al. (2013) for the iterative prefix *re-*. Sentences such as *Linda received a pink lamp again* are presented in contexts where Linda either had received a pink lamp previously or not. For one third of the items, a comprehension question assessed the extent to which subjects accommodate Linda receiving a pink lamp on a previous occasion when the immediate context did not support this. In particular, subjects had to answer whether Linda had received one or at least two pink lamps in total. Somewhat surprisingly, the presupposition of *again* hardly affected subjects' answer choices at all in the non-supporting context, i.e., they overwhelmingly chose 'one' as the answer. The authors interpret this as suggesting that accommodation is a last-resort mechanism that is to be avoided if at all possible. Alternatively, one might explain subjects' behavior in terms of narrowly interpreting the question with regards to the immediate context, but even so, it is very interesting that the presupposition does not seem to counter such a restrictive interpretation at all.

To investigate the proposals from the previous two studies directly, Bacovcin et al. (2016) use a picture matching task with variations in whether the presupposed content is explicitly supported, left uncertain (through the use of '?' in parts of the picture), or explicitly not met. Comparing the triggers *continue* and *again*, they find clear differences in confidence ratings and reaction times

between conditions allowing for accommodation and ones explicitly inconsistent with the presupposition. Furthermore, hardly any differences arise between these triggers, and no cost of accommodation is detected. The authors argue these results to speak against accounts based on the idea that presuppositions of triggers like *again* can be ignored entirely, or alternatively that accommodation is avoided for them whenever possible. Their results provide clear evidence that the presuppositions of both *again* and *continue* are considered even in an experimental setting where they do not play any crucial role for the task at hand. They thus suggest that the presupposed content is fully considered for all triggers across contexts, and furthermore that accommodation even takes place when not strictly necessary.

2.4 The Timecourse of Presupposition Interpretation

While some of the response time and self-paced reading studies discussed above help to shed some first light on the time course of presupposition interpretation in online processing, they only do so at a fairly coarse-grained level. A more fine-grained temporal perspective not only serves to increase the general understanding of the cognitive processes involved in interpreting presuppositions, but also helps to assess theoretical comparisons between presuppositions and implicatures. Various authors (including Bott & Noveck, 2004; Huang & Snedeker, 2011) have argued that implicatures are delayed in online processing, and if certain presupposition triggers in fact are a type of implicature (among others Abusch, 2002; Romoli, 2014), we may expect similar effects here.⁸

In recent years, more fine-grained methods for investigating online processing have been used to study presupposition as well. First, some of the self-paced reading studies above have been extended to eye tracking during reading. Most relevantly, Schwarz & Tiemann (2012, also see Schwarz & Tiemann 2016) investigate German sentences with *again* in contexts that either are or are not consistent with its presupposition. They find slow-downs in the earliest fixation measures, including first fixation duration, in reading times on the verb that immediately follows *again*. These effects provide temporally fine-grained evidence that presuppositions are integrated with the discourse context more or less immediately (at least in unembedded contexts; see section 4.1 for embedded cases). Along the same lines, Clifton (2013) also reports eye-tracking effects parallel to the self-paced reading data discussed above in first-pass time measures.

In addition to these reading studies, several recent eye tracking studies have used the visual world paradigm (Tanenhaus et al., 1995) to investigate presupposition processing. These involve visual stimuli with a number of alternative candidates for reference, paired with auditory linguistic stimuli. Participants' eye movements are monitored as the linguistic input unfolds, and the general design is set up so that looking preferences can be interpreted as indicating the

⁸But note that there is an ongoing debate on whether implicatures are indeed delayed (Grodner et al., 2010; Breheny et al., 2013; Degen & Tanenhaus, 2016).

availability of the interpretation of interest at a given point in time. Chambers & Juan (2005, 2008) investigate *another* and *return* with this method, and find rapid shifts of fixations based on the respective presuppositions. More recently, Romoli et al. (2015) look at English *also* in comparison with the asserted part of *only*. They find shifts in eye movements based on the presupposition of *also* as early as 400ms after its onset, indicating that the presupposition is utilized in determining the referent before further disambiguating information is introduced.

Schwarz (2015b) contrasts the same two expressions, and observes a shift in fixations as early as 200-300ms after the onset of *also*, suggesting that the presupposition introduced by *also* is immediately available and utilized in identifying the referent. A second experiment looks at the interpretation of stressed *also*, which associated with the subject of the sentence, again in comparison to the asserted exclusivity of *only*. While *also* again gave rise to an essentially immediate shift in fixations towards the target (starting at 300ms after the onset of *also*), the exclusive inference introduced by *only* did not give rise to a parallel shift until 700ms after its onset. Extending this approach, Schwarz (2014) compares a hard and a soft trigger, *again* and *stop*, to assess whether the potentially pragmatic nature of the latter might lead to differences in processing speed, given related findings for implicature (Huang & Snedeker, 2011). However, both triggers very much parallel the time-course observed in the previously discussed studies on *also*, with immediate shifts in fixations based on the presupposed information.

The results from these studies, together with the reading results above, thus do not provide any support for the notion that at least some presuppositions are pragmatically computed in a costly manner associated with processing delays. This may be most naturally compatible with accounts that assume all presupposed content to be encoded conventionally. But it is also possible that we are looking at rapid pragmatic effects, so the results do not *per se* settle the question about the source of presupposed content.⁹ (Parallel issues arise in the experimental study of scalar implicatures; see Breheny, this volume). Nonetheless, they provide the most direct and time-sensitive evidence yet that presupposed information is available and utilized as soon as the presupposition trigger is introduced.

2.5 Interim Summary

Experimental work on presuppositions in unembedded contexts has established basic methodological approaches for detecting presuppositions, although it is also clear that their impact can be fleeting when subjects do not fully engage with the linguistic stimuli. The backgrounded status of presuppositions is reflected in the fact that they do not seem to receive much attention in initial phases of sentence verification, given the response-time delays for judgments

⁹Another possibility is that presuppositions in affirmative contexts are also part of what is entailed (see section 3.3.2 for discussion), which could be another explanation of the fast availability of presupposed content.

based on false presupposed information. While no knock-down arguments for or against any theoretical perspective can be made based on the time-course of presupposition interpretation, it is important to note the apparent contrast between presuppositions and implicatures in this regard, given theoretical approaches that essentially reduce certain presuppositions to implicatures.

When presuppositions are not supported in the context, this generally invokes accommodation. While triggers do seem to differ in terms of ease of accommodation, the common claim in the theoretical literature that some triggers entirely resist accommodation does not seem to be borne out. Future work is needed to gain a better understanding of what factors facilitate accommodation and to account for them in theoretical terms.

3 The Interpretation of Triggers in Embedded Environments

Since projection is generally taken to be a hallmark feature of presuppositions, it is only natural for experimental work to address projection-related phenomena as well. A first challenge is to identify precisely what the nature of the projected content is. Theories differ in their predictions in this regard, both with respect to embedding under quantifiers and sentential operators, and the empirical situation is in many ways too subtle to settle the facts without more comprehensive experimental approaches. As noted above, projection does not always take place, and the availability and status of the resulting local interpretations has been subjected to experimental study as well. Finally, much of the discussion about potential differences between triggers is based on claims about differences in projection behavior, and various experimental attempts have been made to assess these claims.

3.1 Identifying what Projects

3.1.1 Projection from the Scope of Quantifiers

As noted in section 1.2.2, an important question to settle is whether presuppositions in the scope of quantificational expressions project existentially or universally (or whether this varies by trigger). Chemla (2009b) provides a first experimental attempt to address this by looking at sentences such as *No student knows he's lucky*. He presents these sentences, and variations with a range of other quantifiers, to subjects and asks them to judge whether (or, in a second experiment, how strongly) the sentence suggests that all of the students are lucky. Judgments for the quantifier *no* pattern together with those for *every* and indicate a universal presupposition, whereas universal inferences for numerical quantifiers (e.g., *more/less than 3*) are less strongly supported. Chemla proposes to capture the results in terms of Similarity Theory (Chemla, 2009a), which allows the quantificational force at play in the presupposition to vary across quantifiers.

Using eye tracking during reading, Tiemann (2014) reports a German study that manipulates context sentences for quantificational target sentences precisely with respect to whether the relevant presupposition is met universally or not. Her results find slow-downs in reading time for *jede* ('every') in non-universal contexts, but not for *ein* ('one'). Parallel to Chemla's findings, this suggests that the nature of the projected presupposition depends on the quantifier.

Geurts & van Tiel (2015) investigate the effects of presuppositions on domain restriction. Pairing simple geometrical figures with sentences in a truth value judgment task, they look at quantified sentences such as *Each of these 7 circles has the same color as the square that it is connected to*. Rather strikingly, they find that even a picture where only 2 out of the 7 circles presented are connected to the square next to them (and have the same color) yields a substantial amount of 'true' judgments - up to 68% of the time based on the visual display. The authors analyze this in DRT and propose that such judgments are based on intermediate accommodation, but the effect could also be attributed to a form of domain restriction. Another finding, which seems to be in direct contrast with Chemla (2009b), is that acceptance of sentences with *none* are at ceiling level throughout, suggesting an existential, rather than a universal presupposition.

Most recently, Zehr et al. (2015) argue based on a picture matching task using the trigger *win* that, descriptively speaking, *none* can exhibit both existential and universal readings (in addition to a local accommodation reading). They then lay out various options that different theories have for deriving alternative (weakened or strengthened) readings through other mechanisms. In a follow-up acquisition study, Zehr et al. (2016a) find that child data exhibits a contrast between conditions revealing a universal projection reading, but no evidence for existential readings is found. They argue the emerging picture to favor a view where projection for *none* is universal, with additional mechanisms like domain restriction responsible for deriving a weakened, existential reading (which may be developmentally later, given that it is more complex).

3.1.2 Projection from Sentential Operators

Turning to embedding under sentential connectives, there is substantial disagreement in the theoretical literature on whether a presupposition trigger in the consequent of a conditional (such as the possessive definite in 16) gives rise to a conditional presupposition (16a, e.g., on classical dynamic semantic accounts) or a non-conditional one (16b, e.g., on DRT accounts):

- (16) If Al goes surfing, he'll wear his wet-suit.
- a. If he goes surfing, he has a wet-suit.
 - b. He has a wet-suit.

Both interpretations seem to be attested, but theories differ in terms of which one they see as basic. Romoli et al. (2011) provide a first experimental exploration of this topic using a covered box picture matching task (Huang et al.,

2013), and argue their results to favor accounts that predict a conditional presupposition as the basic one. Their results also support the notion that whether or not the presupposition intuitively can be seen as dependent on the content of the antecedent affects judgments.

Another line of experimental work on projection investigates the role of incrementality, based on the idea from Philippe Schlenker’s work (Schlenker, 2008a,b, 2009) that presupposition projection can be broken down into a symmetric semantic component and a processing-based incremental component. Crucially, order-based incremental effects (as in 6b) are attributed to left-to-right processing, but are in principle violable. This opens up interesting questions about presupposition processing. Chemla & Schlenker (2012) home in on this issue and test presupposition triggers in conditionals, disjunctions, and *unless*-sentences in configurations where the presupposition trigger appears either in the linearly first or second clause. In an inference judgment task, they find that subjects endorse conditional inferences more strongly than non-conditional ones, regardless of where the presupposition trigger is introduced. They interpret this as support for a symmetric theory of presupposition satisfaction, where material introduced later on in the sentence in principle can provide support for an earlier presupposition. Schwarz (2015c) varies this paradigm by looking at conditionals in a covered box picture selection task and varying the position of the *if*-clause. The results here are more mixed, in that *if*-clause initial conditions suggest a fairly strong role of incrementality, while the *if*-clause final conditions are more in line with symmetric predictions.

Hirsch & Hackl (2014) investigate the effects of incrementality in disjunctions. These pose a potential challenge to a general processing-based effect of linear order, as they seem entirely symmetric, e.g., in the following famous example due to Barbara Partee:

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

Unlike in conjunctions, a trigger in the first disjunct does not generally project globally, i.e., (17) appears to be equivalent to a variant with the disjuncts reversed. However, Hirsch & Hackl (2014) argue that we are actually dealing with a case of local accommodation (discussed in more detail in the next section), as a global presupposition interpretation would be inconsistent with the non-presuppositional disjunct, and each disjunct is independently required to be a live possibility in the global context. Rather than predicting an overall asymmetry in projection parallel to conjunction, an incremental account of projection then will merely predict a processing effect due to a garden path effect, as the global reading is considered first and then abandoned. The authors assess this by having subjects select the more natural of two sentences, one parallel to (17), the other with an additional presupposition trigger that is consistent with a global interpretation of the other trigger. The results are in line with the authors’ predictions in that a stronger preference emerges for the version consistent with a global presupposition when the trigger appears in the second conjunct. In contrast, control sentences that at no point suggest a global

presupposition interpretation display no effect of order. Initial online evidence in line with this analysis based on a global, non-conditional presupposition is provided by Hirsch et al. (2016), who use visual world eye tracking and argue that global interpretations are temporarily considered even when they cannot be ultimately maintained.

3.2 Local Readings

While it's commonly known that there are exceptions to projection, it's important to note that just because a presupposition does not project doesn't mean that it disappears entirely. Indeed, many accounts assume that what happens in (at least some of) such cases is that it gets locally accommodated (as first proposed within context change semantics by Heim, 1983, though parallel effects can be derived in other frameworks, e.g., through Beaver & Krahmer 2001's A-operator in trivalent ones). This offers an explanation for the fact that sentences such as *The king of France is not bald - because there is no king of France!*, (already discussed by Russell, 1905), are quite acceptable, despite the incompatibility that would be expected based on a global existence presupposition of *the*. The consensus in the theoretical literature has been that local interpretations are dispreferred (beginning with Heim, 1983), though this is only based on authors' intuitions. More recently, Chemla & Bott (2013) offered the first experimental evidence to support that assessment, using a truth value judgment task with sentences such as (18) and looking at reaction time measures.

(18) Zoologists don't realize that elephants are reptiles.

The factive verb *realize* presupposes the truth of its complement clause, and on its global interpretation, this presupposition prevails even in the context of negation (see Tian and Breheny, this volume, for a more general discussion of negation). However, a local interpretation would have that inference negated. In the latter case, the sentence should be judged true, whereas on the former, it should be judged false. Both types of responses are given by subjects throughout the experiment, but the 'true' responses take significantly longer than 'false' responses. Chemla and Bott interpret this as evidence for traditional, semantic accounts that take local accommodation to be a last resort repair strategy. In contrast, the results are argued to be incompatible with pragmatic accounts, such as Schlenker (2008a), which assume that the local reading corresponds to a literal semantic reading, while the global reading requires additional pragmatic inferencing.

Romoli & Schwarz (2015) utilize a different task to investigate the speed of local interpretations of the presupposition introduced by *stop* under negation, namely a 'Covered Box' version of a picture selection task (Huang et al., 2013). Subjects have to select a match for a given sentence amongst various pictures, one of which is 'hidden'. The basic idea is that if the presuppositional inference of interest plays a role in subjects' interpretation, then they should choose the covered box in cases where no overtly shown image is compatible with the

inference. Their experiment compares cases where the overt picture supports the presupposition with ones where it doesn't. Acceptance rates were much lower for target pictures corresponding to the local interpretation. Furthermore, response times for target choices were slower for local target acceptances than for global ones, in line with Chemla & Bott (2013). Extending this approach to other populations, Bill et al. (2014) and Kennedy et al. (2015) use the same task, though without measuring response times, for testing the interpretation of presuppositions under negation in children and Broca's aphasics respectively. Both groups turn out to be much more likely than healthy adults to adopt a global presupposition interpretation, which the authors argue to support the notion that local interpretations are derived, rather than basic, parallel to the findings in Chemla & Bott (2013).

3.3 Differences in Projection between Triggers

3.3.1 Soft vs. Hard Triggers and Local Accommodation

Much of the discussion in the literature concerned with identifying differences between (classes of) presupposition triggers is based on the observation that some triggers seem to project more persistently than others. Abusch (2002, 2010) considers examples like the following, for example:

- (19) I don't know if Paul participated in the race, ...
- a. but, if he won, he must be very proud.
 - b. ?? but, if Mary participated too, they probably had a drink together just after.

The presupposition of *win*, that Paul participated in the race, does not seem to be globally present, as it would be inconsistent with the context sentence. However, the global presupposition of *too*, that someone else (salient in the context) participated in the race seems to give rise to a certain amount of oddness, suggesting a global reading is required, or at least more strongly preferred. Jayez et al. (2015) investigate this contrast experimentally, by looking at presupposition triggers in the antecedent of conditionals. Looking at French *aussi* ('too'), *regretter* ('regret'), and clefts, they present evidence that the distinction is not entirely robust, in that 'hard' triggers, too, allow local readings. Differences between triggers furthermore seem to interact with other contextual factors. The authors argue their results to be consistent with a three-way distinction between presupposition triggers, in line with Jayez (2013). In a related vein of ongoing work using the Covered Box task, several studies have found evidence for the availability of local accommodation for Abusch's 'hard' triggers. For example, Bacovcin & Schwarz (2016) report evidence for local interpretations of *again* in negated conjunctions (where the local contribution can be uniquely identified while making an alternative interpretation in terms of metalinguistic negation highly unlikely). Furthermore, Zehr et al. (2016b) report on the interpretation of *again* in both positive (*Either... or...*) and negative (*Neither... nor...*) disjunctions, and find evidence for the existence of local interpretations, which

furthermore can be primed by exposure to blocks of trials where such an interpretation is the only one compatible with any given picture.

Other work aims for a more comprehensive overview of ‘projection strength’ across a larger number of triggers. Smith & Hall (2011) investigate projection strength of various presupposition triggers, as well as of conventional implicatures, in a host of ‘family of sentences’ environments (Chierchia & McConnell-Ginet, 1990). They use a ‘surprisal’ judgment, where subjects have to assess how surprised they would be to learn that the presupposed proposition holds after hearing a sentence containing the trigger. Their findings are uniform for conventional implicatures and presuppositions (which they argue to speak in favor of a unified treatment of projection, as in Tonhauser et al., 2013), but also suggest that projected content has a somewhat weaker presence than non-projected (i.e., asserted or unembedded presupposed) content. They also find some variation between triggers, though it does not line up neatly with theoretical differentiations proposed in the literature. Ongoing work by Judith Tonhauser and colleagues, reported in Tonhauser (2015), takes this comparative approach further and finds that projectivity is correlated with measures of at-issueness, in line with the pragmatic approach to projection spearheaded by Simons et al. (2010). They furthermore find that triggers that Tonhauser et al. (2013) argue to give rise to Obligatory Local Effects (also see discussion in the next section) are relatively less likely to project than other types of projective content that don’t (necessarily) contribute locally.

The work by Cummins et al. (2013, and also Amaral & Cummins 2015) discussed in section 2.2 also relates to the issue of differences between triggers with regards to projection. In particular, the relative goodness of *No, because...* replies, where the presupposition is directly contradicted in the *because*-clause, for some triggers (such as *regret, stop, still*) can be analyzed as reflecting those triggers’s amenability to local accommodation. While they base their discussion on the distinction between lexical vs. resolution triggers (Zeevat, 1992), the data largely align with Abusch’s ‘hard’ vs. ‘soft’ distinction as well (the case of *regret* being a notable exception).

Another line of work already discussed, starting with Romoli & Schwarz (2015), also directly bears on the discussion of possible theoretical distinctions between triggers. While their initial findings of differences between soft triggers and implicatures called into question whether there was solid evidence for a distinction between the two, the subsequent work on different populations by Bill et al. (2014) and Kennedy et al. (2015) provide evidence against an analysis of soft triggers as implicatures (in particular in the version of Romoli, 2014), as they provide a double dissociation with distinct patterns across healthy adults, Broca’s aphasics, and children.

In sum, it’s clear that descriptively speaking, there is variation in the extent to which experimental tasks yield projection-based interpretations across triggers. However, based on the evidence to date, the overall picture of such variation seems to be more gradient than might be expected on categorical distinctions between triggers. It is thus not clear that any such distinctions receive direct support from the empirical work so far, though their proponents can of

course call onto other factors to account for the gradient data. The key challenge that remains for any account of projection is to explain why triggers exhibit such heterogeneous behavior, and whether that should be captured theoretically via a difference in projection mechanisms or through independent factors.

3.3.2 Local Readings Reconsidered: Entailment vs. Local Accommodation

While the terms ‘soft’ vs. ‘hard’ have become fairly standard descriptive labels for distinguishing types of presupposition triggers, there are a variety of different theoretical accounts of this distinction that are separate from the line advanced by Abusch (2002, 2010) when she first introduced these. One common thread in many accounts is that triggers differ in whether or not the entailed and presupposed content directly relate to one another. For example, Zeevat’s lexical triggers are characterized as pre-requisites for the asserted content: “the application of a concept is only an option if certain conditions are already met” (p. 397 Zeevat, 1992). Tonhauser et al. (2013) distinguish a sub-class of triggers that give rise to ‘obligatory local effects’. Both papers cite examples involving triggers in the scope of attitude verbs as indicative of whether a trigger’s presupposition is part of its clause’s contribution to standard compositional interpretation. In a similar vein, Glanzberg (2005) considers a trigger ‘strong’ if context update is entirely impossible unless the presupposition is already met or added to the context. All of these share the notion that with certain triggers, you don’t get to work with entailed content to the exclusion of the presupposed content. One fairly direct way of dealing with this theoretically is to assume that presupposed and entailed content do not have to be mutually exclusive. Sudo (2012) fleshes out a proposal where triggers differ precisely in whether or not the presupposition is also part of the entailed content, and Klinedinst (2012) argues that such a distinction can be used to explain the ‘soft’ vs. ‘hard’ distinction.

While Klinedinst’s discussion of this approach suggests that there may be no direct way of finding independent evidence in favor of this entailment-based distinction, Sudo proposes that the scope of non-monotonic quantifiers, such as *exactly 1*, provides a diagnostic. In effect, what such contexts will reveal is whether or not the presupposition winds up being considered when taking a count based on the predicated properties.

- (20) Context: Some students asked the professor lots of questions on day 1 of the class.
 - a. Exactly one student {continued/stopped} asking the professor lots of questions [on DAY 2]_F.
 - b. Exactly one student (also) asked the professor lots of questions (again) on day 2.

The contrast between triggers like *continue* and *also*, according to Sudo, arises when considering a scenario where another student, who had not asked

many questions on day 1, does ask many questions on day 2 (while only one of the day 1-questioners does so on day 2). With *continue*, this does not seem to affect the truth of the *exactly 1* statement, as there only is one student who asked lots of questions both on day 1 and day 2 (parallel observations hold for *stop* with appropriate changes in the scenario). In contrast, the argument goes, with *also* (as well as *again*), a new student asking many questions on day 2 makes the sentence false, because the entailed content evaluated in the scope of the quantifier merely is about question askers on day 2.

While the theoretical prediction seems clear and provides a useful angle for distinguishing triggers and testing the entailment-contrast hypothesis, the intuitive picture may not be quite as straightforward. Zehr & Schwarz (to appear) present a first attempt to test the analysis of Sudo (2012) experimentally. They use a covered box picture matching task with critical target pictures following the logic of the scenarios described above, comparing *stop* and *also* in *exactly one*-sentences. They find a clear contrast between triggers, with *also* yielding comparable result-patterns in the critical condition and false controls, while *stop* yields significantly more acceptance of the visible picture, supporting the notion that there is a relevant difference between triggers. However, intriguingly, the results also reveal a difference between the critical *stop* items and true controls, which is unexpected if the presupposition is also part of the entailed content evaluated in the scope of *exactly one*. The authors argue that in principle, this could be explained as a task effect of one sort or another, to maintain the entailment-contrast explanation of the difference between triggers. Alternatively, one could revert to a two-dimensional theory where no trigger's presupposition is directly part of what is entailed, though it can become so through local accommodation. What remains to be explained then is why the triggers differ in the availability of this process, as this assumption would be needed to explain the contrast between triggers. While these options will need to be teased apart in further work, a blocked version of the experiment in Zehr & Schwarz (to appear) where *stop* items are seen before *also* items clearly suggests a role of local accommodation for the latter trigger, as an increased rate of critical target acceptances shows up here, albeit with a slow-down in reaction times.

There is yet one further aspect of the interpretation of triggers under quantifiers that the experiments reported in Zehr & Schwarz (to appear) bear on. Charlow (2009, as well as Sudo 2012) claimed that 'hard' and 'soft' triggers differ in their projection patterns across quantifiers, with the former uniformly giving rise to universal presuppositions, while the latter vary between universal and existential ones across quantifiers. The true controls of Zehr & Schwarz (to appear) for both triggers only satisfied the presupposition existentially, however, and yielded ceiling-level acceptance rates for both triggers, suggesting that at least in the context of *exactly one*, both types of triggers only involve an existential presupposition. While the various reported findings here advance our understanding of the empirical picture concerning triggers in the scope of quantificational expressions substantially, the intricacies at both the theoretical and empirical level require much more work to achieve a more satisfying level of

clarity of what the facts are and what analyses best fit them. Thus, this is a fertile area for further research, which will also be crucial for our understanding of the interpretation of presuppositions in embedded contexts more generally.¹⁰

3.4 Summary on Embedded Triggers

The behavior of presupposition triggers in embedded contexts is an intricate topic both in terms of theoretical and empirical perspectives. The empirical work to date suggests that projection from quantifiers is not uniform across all quantifiers, though there is little support for the notion that different triggers give rise to different projection patterns. Experimental results on projection from the scope of sentential operators provides some support for conditional presuppositions projecting from conditionals, as well as for symmetric interpretations paired with incremental effects that may be attributed to left-to-right processing. Evidence from disjunction, on the other hand, suggests that there is at least a strong preference for global, non-conditional interpretations, which seem to be available early on in processing, which opens up the possibility that other interpretations are best accounted for by local accommodation. Local readings, in turn, have been quite consistently shown to be less available than projecting interpretations, though again the extent to which this is true varies across triggers. As with global accommodation, it does not seem to be the case that there are triggers which resist local accommodation altogether, however, which also raises the question to what extent the same mechanisms are involved in local and global accommodation. A different perspective on local contributions of triggers opens up if we consider the possibility that some triggers also contribute their presupposition to the entailed content. Initial experimental results support the notion that triggers differ with regard to their contribution to the local content, though it is not yet clear whether that has to be captured in terms of presuppositions being entailed. Given the complexity of the issues involved, it is unsurprising that the empirical efforts so far have raised at least as many questions as they have begun to answer, but there clearly is a great need to push this field of study further in order for experimental results to have an even greater impact on theoretical questions.

4 Presuppositions in Discourse

While presuppositions are standardly seen to crucially relate to the discourse context, much of the work discussed so far does not incorporate more intricate notions pertaining to the structure of the discourse. But some recent lines of work move towards seeing presuppositions in light of richer characterizations of discourse structure. First, we'll discuss a different approach to investigating projection phenomena, which compares, among other things, intra- vs. cross-sentential resolution of presuppositions. Second, we'll briefly survey experimen-

¹⁰The interpretation of presupposition triggers in the scope of attitude verbs constitutes another important area where experimental work is called for.

tal avenues for investigating the relation between presuppositions, projection, and Questions Under Discussion. Finally, some initial experimental work on the phenomenon of ‘obligatory’ presupposition triggers is considered.

4.1 Resolving Presuppositions in the Discourse Context

Two studies relating to projection are concerned with the resolution of presuppositions in context, either intra-sententially or in the discourse context, and its time-course in processing. First, in two reading time studies using eye tracking, Schwarz & Tiemann (2016) find embedding of presupposition triggers to modulate processing effects. In the first study (already mentioned in section 2.4) immediate eye movement effects on the critical word are found when the context was inconsistent with the presupposition, but only when the trigger (German *wieder*, ‘again’) was outside of the scope of negation. No effects of context emerged when it was embedded under negation, and follow-up studies suggest that this is not due to a general availability of local interpretations. In a second study, presuppositional support for *wieder* in the consequent of conditionals is introduced in varying locations, namely in the antecedent or in a context sentence. Schwarz & Tiemann (2016) interpret the results from this study as suggesting that the hierarchical distance in terms of the projection search path assumed by DRT directly affects reading times on the critical region. Such an effect is less straightforward to derive on non-representational accounts (such as dynamic semantics).

Kim (2015), using the visual world paradigm, takes a different angle and investigates the effects of discourse structure on the selection of an antecedent for *also*. This is done by presenting multi-sentence discourses, which provide various possible antecedents for *also* in the final target sentence. In two initial comprehension studies, Kim asked subjects to choose one of several descriptions of what the sentence with *also* conveyed, which reflects how they resolve its presupposition in the discourse. While there was a general preference for linearly local antecedents in the comprehension studies (where *also* was understood relative to the immediately preceding sentence), a structurally (but not linearly) local interpretation also became available when the discourse structure was manipulated. In a visual world eye tracking experiment, Kim also found a preference for structurally local interpretations. The eye movement results for the condition that involves a structurally local antecedent furthermore add to the evidence from the two studies above, showing that the presupposition of *also* is available immediately in online processing.

4.2 Factives, Prosody, and Discourse

In section 1.2.2, we mentioned recent theoretical developments, spearheaded by Simons et al. (2010), to explain the projective behavior of certain triggers in terms of at-issueness, which in turn can be analyzed in relation to the Question Under Discussion (QUD). In particular, content is at-issue precisely if it helps to answer the QUD. In more recent theoretical work, Simons et al. (2016), this

approach is fleshed out further for the case of factive verbs. An important aspect of this approach, which arguably sets it apart from more traditional approaches, is that whether or not a presupposition projects in a given discourse context will be affected by what the QUD is. Observations to that effect have been in the literature at least since Beaver (2010, with drafts circulated as early as 2002), who described effects of prosody (which on the relevant view is indicative of QUDs) on projection, but not until very recently have there been attempts to investigate this prediction experimentally, with a first published report in Tonhauser (to appear) (see Kim, this volume, and Tonhauser, this volume).

By way of background, one of the central contrasts in this line of work is represented by the following:

- (21) a. If the T.A. discovers that your work is [plagiarized]_F, I will be [forced to notify the Dean]_F.
 b. If the T.A. [discovers]_F that your work is plagiarized, I will be [forced to notify the Dean]_F.
 (Beaver, 2010, 93)

- (22) a. Perhaps he discovered that she's a [widow]_F.
 b. Perhaps he [discovered]_F that she's a widow.
 (Tonhauser, to appear)

With focal stress on *plagiarized* in (21) (or elsewhere within the complement of *discover*), the factive presupposition does not seem to arise, i.e., this does not suggest that the addressee is guilty (though a weaker presupposition that the T.A. will discover something may be at play). In contrast, stress on the factive *discover* itself, does seem to take it as already settled that the addressed student is guilty of plagiarism. Tonhauser (to appear) uses carefully implemented prosodic manipulations of sentences like (22) to experimentally test this variation in projectivity (for an earlier approach testing general effects of prosody on the availability of different interpretations based on various aspects of meaning, including presuppositions, see Cummins & Rohde, 2015). She finds that when asked how confident they are in the embedded clause being true, participants indeed give significantly higher ratings when the focal accent is on *discover*, compared to either on (the equivalents of) *she* or *widow*, though confidence ratings for the projected content are relatively high across the board, at around 5 out of 7. (An additional experiment revealed that the nature of the pitch accents in the complement clause could make a difference as well.)

As Tonhauser lays out in detail, the effect of prosody on projectivity can be captured by the QUD-based approach, as only the versions with stress on the factive have a Current QUD that entails the embedded clause, predicting higher confidence ratings in this condition. She also argues that traditional approaches that have to appeal to a notion of local accommodation to get non-projecting readings do not straightforwardly capture the effects of prosody, as they only invoke this process as a last-resort strategy to avoid serious problems such as uninterpretability. It remains to be seen to what extent it may be possible to

tie in QUD-based views of discourse with a more traditional perspective on presuppositions, which can call on local accommodation based on inferences about the discourse context suggested by prosody. Whichever direction theoretical advances take, the investigation of interactions between the behavior of presuppositions and prosody are certainly an area ripe for more extensive experimental exploration.

4.3 Obligatory Triggers

One final area with some recent initial experimental approaches is that of so-called obligatory presupposition triggers and corresponding inferences (sometimes called anti-presuppositions or implicated presuppositions). It has long been noted that it often seems to be the case that when a presupposition *can* be used, it *must* be used to render the utterance felicitous, as illustrated in the following examples:

(23) {#A/√The} sun is shining.

(24) John {#thinks/√knows} that Paris is in France.

(25) John came to the store. Bill did {#∅/√too}.

(Bade, 2016, p. 19)

Initial theoretical discussions of the definite article go back to Heim (1991), who proposes a principle Maximize Presupposition that requires speakers to make their contribution presuppose as much as possible (another related line of work investigates the impact of informativeness on referential expressions more generally; see Davies and Arnold, this volume). This approach has been further developed and refined by various subsequent authors (e.g. Percus, 2006; Chemla, 2008; Sauerland, to appear; Singh, 2011; Schlenker, 2012). An alternative proposal building on insights by Krifka (1999) and Saeboe (2004) was developed by Bade (2014). The central idea is that leaving out the trigger would give rise to exhaustivity inferences (which she analyzes as obligatory implicatures) that are incompatible with the context. More specifically, Bade assumes that sentences are interpreted as exhaustively answering the implicit Question Under Discussion.

While the reader has to be referred to Bade’s work for further details, Bade (2016) crucially homes in on two predictions on which the two accounts come apart: first, Maximize Presupposition predicts that the relevant inference remains present even when embedded under operators such as negation, whereas Bade’s Obligatory Implicature approach does not predict them to arise in that context. Secondly, only the Obligatory Implicature approach predicts that the presence of the inference could be modulated by varying the QUD. Bade (2016) reports experimental investigations of additives, iteratives, and definite descriptions to assess these predictions. Her main findings, based on acceptability rating studies, are that the first two do not give rise to the relevant inference under negation but are subject to modulation by contextual manipulations affecting the QUD, suggesting that the relevant inferences in these cases are best

accounted for by the Obligatory Implicature approach. (Interestingly, Bade also argues *know* to pattern with additives and iteratives in these regards, though she does not present experimental data on this). In contrast, definite descriptions pattern essentially the opposite way, suggesting that they are cases where the relevant inferences are attributable to Maximize Presupposition.

From this brief discussion, it should already be clear that the phenomenon of obligatory triggers and corresponding inferences provides rich grounds for more extensive experimental exploration, in particular in light of the potential interplay of different principles and different aspects of meaning, including exhaustivity, implicatures, and presuppositions. Bade’s finding that there does not seem to be a uniform picture with regard to how triggers pattern relative to crucial theoretical predictions furthermore contributes to our understanding of the variations in the behavior of presupposition triggers, which need to be integrated into the broader theoretical debate about distinguishing types of triggers.

5 Conclusion & Outlook

Recent years have seen rapid growth of experimental work on phenomena related to presuppositions, and quite a bit of progress has been made already, in refining methodologies, clarifying the empirical landscape, and consequently informing theoretical debates. Even in fairly artificial experimental contexts, the contribution of presuppositions is largely robust and automatic. The interplay of presuppositions with both their intra-sentential and larger context requires careful control over all aspects of experimental stimuli. Many results have lent further support to the notion that (classes of) triggers differ from one another in various ways, but these differences are neither absolute or categorical, nor do they straightforwardly support any current conceptual approach to differentiating triggers. While all aspects of the study of presupposition will benefit from further experimental work, the behavior of embedded triggers and the relation of triggers to more intricate aspects of discourse and discourse structure seem like an especially important area that deserves further scrutiny.

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