Yale University

If SOME folks are wise, are others otherwise?

The interaction of context and emphasis in online scalar implicature processing

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Abstract

Can conversational implicatures be influenced by prosodic emphasis? If emphasis does play a role, how does it influence the time-course of online sentence comprehension? Scalar implicature (e.g., when a speaker uses *some* to mean *some but not all*) has been a primary subject of experimental investigation into the pragmatics-semantics interface. Prior studies of the effects of context on online implicature processing suggest that sentence context can influence how quickly an upper-bounded, "pragmatic" reading of *some* is generated (Breheny et al., 2006; Hartshorne and Snedeker, *submitted*; Politzer-Ahles and Fiorentino, 2013). Other studies suggest that prosodic effects are often used to disambiguate aspects of semantics and syntax, and that prosody also plays a large role in pragmatic reasoning (Ward and Hirschberg, 1985; Price et al., 1991; Shattuck-Hufnagel and Turk, 1996; Snedeker and Trueswell, 2003). Previous studies have not, however, directly examined the role of prosody in online scalar implicature processing. In a self-paced reading experiment employing a tightly controlled graphical manipulation (all-caps) as a cue to prosodic emphasis, I did not find evidence for facilitation of scalar implicature generation. This does not mean prosody does not play a role in scalar implicature processing, but rather that further research will be required to determine its effect.

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1. Introduction

In the fierce debate over where to draw the line between semantics and pragmatics, termed "the Border Wars" by Horn (2005), scalar implicature has long been a key battleground. It is a battle that is being waged on two fronts, both in the theoretical literature and in the relatively new field of experimental pragmatics. In the first section of this paper I will lay out what I see as the main theoretical positions on scalar implicature—those of the (Neo)-Griceans (e.g. Horn 1972, 1973, Gazdar 1979, Levinson 1983, Hirschberg 1991), Relevance Theorists (e.g. Sperber&Wilson, 1986; Carston, 1998), and of Levinson (2000). Next I will give a review of some of the key findings on scalar implicature from reaction time studies (e.g. Bott and Noveck, 2004; Breheny et al., 2006), self-paced reading experiments (Breheny et al., 2006; Hartshorne and Snedeker, *submitted*; Politzer-Ahles, *in press*), and other psycho/neurolinguistic experiments (e.g. Noveck and Posada, 2003; Huang and Snedeker, 2009; Grodner et al., 2010; Huang and Snedeker, 2011; Guerts et al, 2011), and discuss how they have or have attempted to inform the theoretical debate.

Though many of the experimentalists whose work I will discuss have attempted to use their results to argue for or against a particular theoretical position on scalar implicature, this is not my goal (and would be far beyond the scope of this study). Rather, it is my project to draw the oft-neglected but crucial field of prosody into the conversation between experimentalists and theoreticians in the context of scalar implicature. Prosody—the melody and rhythm of speech—and its importance in the processing of utterance meaning is often mentioned in the theoretical literature. Whenever a certain tone is required to achieve the intended understanding of the utterance, or a certain reading is called "marked", this is an artifact of prosody (Milsark, Geurts 2009: 73-74, Geurts and vantiel, 2012; King & Stanley 2005, Horn 2005, 2011). Prosody is also becoming the focus of a great deal of experimental work that has begun to establish how stress and emphasis are prosodically encoded, how the brain processes prosodic forms, and how prosody interacts with syntax in real time (Price et al., 1991; Shattuck-Hufnagel and Turk, 1996; Cutler et al., 1997). Some work has also touched on the prosody-pragmatics interface, and supports the conclusion that prosody does affect pragmatic reasoning (see for example: Ward and Hirschberg, 1985; Pierrehumbert, 1990; Hirschberg, 2002; Snedeker and Trueswell, 2003; Hirschberg, 2004).

In this paper, I present a self-paced reading experiment, which builds off previous work on the time-course of scalar implicature processing, particularly Hartshorne and Snedeker (*submitted*). Rather than examining the role of context, however, I develop a paradigm for examining the role of prosody by using all-capitals text as a visual cue to emphasis. Based on previous theoretical and experimental work I hypothesized that prosodic emphasis as signified by writing in all-caps would facilitate scalar implicature generation, even in contexts in which it would otherwise be blocked or delayed (conditional sentences). I ran two similar experiments, but ultimately, I did not find results to confirm my hypothesis. I will discuss possible reasons for my failure to achieve statistically significant results (among them, the lack of sensitivity of the self-paced reading technique), some trends in the data that could be promising, and avenues for future analysis and research. My results should not be taken as an indication that prosody does not play a role in scalar implicature generation, but rather suggests that different approaches may be required to investigate its effects.

1.1 Background: The Landscape of the Scalar Implicature Debate

A sentence is much more than the sum of the literal meanings of a string of words. The context in which the sentence is uttered, the tone one uses, and the assumptions and intentions of the speakers involved in the exchange all affect the meaning that is communicated. This fact has been acknowledged by scholars since long before Grice founded the modern field of pragmatics. Fifteen hundred years ago, Servius and Donatus characterized litotes (pragmatic understatement) as a figure in which we say less but mean more (via Horn, 2004). Philosophers have for hundreds of years argued about the true meaning of the word *some*. Arguing against the notion that *some* simply always means *some but not all*, John Stuart Mill wrote:

> No shadow of justification is shown … for adopting into logic a mere sous-entendu of common conversation in its most unprecise form. If I say to any one, "I saw some of your children today," he might be justified in inferring that I did not see them all, not because the words mean it, but because, if I had seen them all, it is most likely that I should have said so: though even this cannot be presumed unless it is presupposed that I must have known whether the children I saw were all or not. (Mill, 1867: 501 via Horn, 2000)

The capacity to mean something more or something different from what is explicitly stated is essential to language as we know and use it. It forms the basis of metaphor and humor, allows for the subtle language of literature, and even makes possible pedestrian politeness and small-talk. It is what allows language to serve as the lubricant and life-blood of the complex social systems of human society.

And yet, for philosophers and linguists, the difficulty of reducing natural language to logical forms posed a huge problem. A goal of formal semantics was and is to define linguistic meaning in the terms of formal logic. Using Frege's predicate calculus, sentences could be expressed as formulas—relationships among symbols—and their meaning defined by the truth-conditions of the propositions they encoded (Zalta, 2012, *Stanford Encyclopedia of Philosophy*).

Neglected in such a treatment of natural language, however, is the discrepancy between logical operators and the way in which their natural-language analogues are used in real conversations. If natural language expressions could not be reduced to logical forms, then the truth-values of those expressions could not be established. This left the field of semantics on shaky ground. How could semantics purport to provide even the beginning of a structure of meaning if the basic atoms of meaning could not be determined with any certainty from actual utterances?

1.2 The (Neo)-Gricean Position: The Classical Divide between Semantics and Pragmatics

1.2.1 Grice and the Cooperative Principle

Grice recognized the disparity between formal logical operators and the meaning conveyed by their so-called analogues in speech, but he also recognized that people use language to communicate successfully—suggesting some kind of rule-governed system. In order to rescue formal semantics from a quagmire of uncertainty and bridge the gap between the formal-logic-based semantics, "what is said," and what speakers actually mean, Grice introduced the concept of "implicatures" (Grice, 1961). According to Grice a speaker's (or utterer's) meaning could be divided into those things that are explicitly said—things that are part of the propositional content of the sentence, affect truth-values, or relate to reference resolution—and things that are implicated (Grice, 1967). Grice (1961) gives four examples of meaning beyond “what is said”:

(1) Smith has quit smoking.[1]
(*Smith smoked in the past*)

(2) She was poor but she was honest.
(*there is some contrast between 'poor' and 'honest'*)

(3) Jones has beautiful handwriting and his English is grammatical.
(*Jones is not good at philosophy*)

(4) My wife is either in the kitchen or the bathroom.
(*I don't know for sure which*)

Sentence (1) is an example of a presupposition—something assumed to be true but backgrounded in the conversation. (2) through (4), however, are implicatures. The implicature in sentence (2) is, according to Grice, generated by the form of the utterances, not by the content. By contrast, (3) and (4) are what he terms "conversational implicatures," and they arise on the basis of what was said (depending on context). Sentence (3) is a particularized conversational implicature. The implication that Jones is no good at philosophy arises only under the condition that (3) is uttered in the context of a recommendation letter for a position in a philosophy department. The implicature in (4), however, arises unless specifically canceled in some way by the context (or explicitly by the speaker), making it a "generalized conversational implicature" (Grice, 1967). In this paper I will focus on generalized conversational implicatures (GCIs). Grice's understanding of the nature of GCIs is often obscured by the treatment of the theoretical debate in experimental papers. According to Grice:

> A generalized conversational implicature can be canceled in a particular case. It may be explicitly canceled, by the addition of a clause that states or implies that the speaker has opted out, or it may be contextually canceled, if the form of utterance that usually carries it is used in a context that makes it clear that the speaker is opting out. (Grice, 1967: 39)

Grice (1961, 1967, 1975) argues that the implicatures generated in (3) and (4) are not part of the explicit content of the utterance, but instead can be derived based on pragmatic principles. Conversation is a cooperative effort driven by the goal of mutual understanding. According to Grice, speakers can thus be expected, all other things being equal, to obey "The Cooperative

[1] I am aware that Grice's original example was "Smith has left off beating his wife," but I do not believe this objectionable sentence need be perpetuated in the literature simply because Grice used it at a time when it seemed acceptable as an example. The implicature can be illustrated without violence.

Principle, "Make your conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged" (Grice, 1989: 26). The Cooperative Principle is made clearer and more usable as a rule by four maxims:

Quantity—Make your contribution
1. As informative as is required.
2. No more informative than is required

For the purposes of the current exchange.

Quality—
1. Do not say what you believe to be false.
2. Do not say that for which you lack evidence.

Relation—Be relevant.

Manner
1. Avoid obscurity of expression
2. Avoid ambiguity
3. Be brief (avoid unnecessary prolixity)
4. Be orderly.

(Grice, 1975)

These maxims follow from the notion that conversation is a rational, cooperative activity. Given that speakers can be expected to do their best to follow the maxims above, we can then use the maxims to uncover a speaker's intended meaning from the surface form of an utterance. Implicatures are generated when a maxim appears to be violated. Consider, for example, the statement:

(5) Some of my friends are lovely people.

In making this statement to a group of my friends, it is likely that they would be irritated with me. This is because, all other things being equal, (5) will be interpreted to mean "Some *but not all* of my friends are lovely people." The Gricean Maxims allow us to account for this upper-bounded reading in the following way: a) The Quantity Maxim states that speakers should make their utterances as informative as possible, b) saying "all" would have been more informative (and no more effortful) than saying "some", c) the speaker chose to use a less informative quantifier, d) the speaker must have done so in order to preserve the Quality maxim, e) the speaker must not have had the evidence to say *all* or else believed an *all* statement to be false, f) the speaker either means *some but not all*, or *some but for all I know not all.*

1.2.2 Neo-Gricean Scalar Implicature

Grice himself recognized that his maxims overlap to some extent, and are not all equal in rank (Grice, 1989 via Horn, 2011). Accordingly, the maxims and rules of scalar implicatures are further formalized by Horn (1972, 1989). Horn's formulation privileges the maxim of Quality, or truthfulness, without which, Horn (following Grice) argues, the question of whether or not the other maxims have been violated fails to arise. The maxims of Quantity, Relevance, and Manner, are then subsumed under two principles:

> Q-Principle: Say as much as you can [given R]
> R-Principle: Say no more than you must [given Q]
> (Horn, 2004)

Implicatures arise in a clash between maxims, and conversation can be understood as a balancing of competing imperatives: to be minimize effort while maximize understanding (Horn, 1984). Implicatures like the one in (5) are said by Horn to be Q-based implicatures. The use of the word *some* gives rise to a scale of linguistic alternatives—"contrastive expressions of the same grammatical category, which can be arranged in a linear order of degree by *informativeness* or semantic strength" (Levinson, 1983: 133). In the case of (5), the word *some* can be seen as part of the scale <some, many, most, all>. By choosing to use a weaker term on this scale, the speaker is being less than maximally informative, implicating that the speaker did not have the evidence to make a stronger statement, or else believed the stronger statement to be false. The implicature arises from a clash between the need to be informative and the need to be truthful.

All this effort to characterize pragmatic rules leading to the generation of scalar implicatures raises the question, why not simply posit that the upper bound is lexically encoded in the word *some*—that *some* simply means *some but not all*? One explanation can be found above. A *some but not all* semantic interpretation does not capture the possible *some and for all I know not all* meaning. Another reason not to posit a semantic upper-bound is that the upper bounded reading is cancelable. What this means is that the upper bound can specifically be severed or negated without negating or contradicting the utterance as a whole. For example:

(6) Some of my friends are lovely people; in fact, they all are.

This would, perhaps, be an odd statement to make, but it would probably not be argued that in uttering it I had contradicted myself. By contrast, I simply cannot say:

(7) #Some of my friends are lovely people; in fact, none of them are.

The lower bound is not cancelable in the way the upper-bound is, suggesting that it is somehow more fundamentally tied to the meaning of the word *some* than the upper-bound. Another reason to doubt that *some* is semantically upper-bounded is the fact that it does not arise in all cases. For example, the sentence:

(8) "If you eat some of your vegetables, you can have dessert"
(example taken from Hartshorne and Snedeker, *submitted*)

This sentence is not usually understood to mean "If you eat some *but not all* of your vegetables, you can have dessert." In (8), the upper-bounded reading of *some* does not seem to arise. It would be very odd to respond to (8) by saying, "Aha, you ate *all* of your vegetables. No dessert for you!" and if one did respond this way, it would likely be taken as facetious or capriciously cruel.

One way to explain the one-sided reading of *some* in these cases is to posit that there are simply two different lexically-encoded versions of the word *some*, one two-sided, one one-sided (à la Hamilton, 1860). This explanation, however, runs contrary to Grice's *Modified Occam's Razor* principle, that "senses are not to be multiplied beyond necessity" (Grice, 1989). Additionally, as Mill pointed out in his quote about having seen “some of your children,” a speaker may say some simply because he or she does not know whether all applies or not. Saying “John ate some of his vegetables,” for example, could mean simply that the speaker does not know whether John ate them all. It is hard to see how this understanding could be reached by simply positing two semantically-encoded versions of some (one-sided or two-sided), with no room for ambiguity in either.

If we abandon the purely semantic line of thinking, it becomes necessary to determine another explanation for the cases in which an upper-bounded reading of *some* is not generated.

1.2.3 Downward-Entailing Contexts, Scalar Implicature blocking or reversal

Gazdar (1979) proposes that scalar implicatures are blocked in embedded contexts. For example:

(9) It is not the case that Paul ate some of the eggs. (Horn, 2009)

Sentence (9) is generally taken to mean that Paul did not eat any of the eggs. It is thus a negation of the lower-bounded reading of *some*, and does not usually mean Paul ate *all* or *most* of the eggs.[2] Consider, however, the following example:

(10) Julius believes that some of the goats are happy. (Geurts, 2012)

In (10), the scalar term is in an embedded context, and yet, a possible reading of the sentence is that Julius believes "some *but not all* the goats are happy." An alternative to Gazdar's (1979) proposal is that scalar implicatures are blocked not by any embedded contexts but only by overt negation (Hirschberg, 1991). This would include sentence (9) and others like it. While Gazdar's theory produces too many "blocking" contexts, Hirschberg's produces too few. Sentence (8), as noted above, does not seem to lead to an upper-bounded reading of *some*, but it is not a case of overt negation.

Horn (1989: 233-34) takes a position between Gazdar's and Hirschberg's: scalar implicatures are blocked in downward entailing (DE) contexts. A DE context is one in which entailment scales are reversed. In other words, "they are expressions that license inferences from supersets to subsets" (Janssen, 2012, *Stanford Encyclopedia of Philosophy*). This includes conditionals (as in (8)), negation, and most other negative polarity item (NPI) licensing contexts (see Horn, 1989).[3] For example, *No* is downward entailing because *No man walks* entails *No tall man walks*. By comparison, in a non-DE context, *A tall man walks* entails *A man walks*, not the other way around. Based on the entailment-scale-reversing properties (Fauconnier, 1975), others have argued that DEs do not "block" scalar implicatures, but simply reverse the scale of

[2] See section 2.2 for a discussion of Hirschberg's account of the role of prosody in cases like (9)
[3] Negative polarity items like *any* and *ever* are licensed by DE contexts (Ladusaw, 1979).

alternatives over which the implicature is generated (Levinson 2000: 254-55). Consider the following example:

> (11) If some of my friends come to the party, I'll be happy, but if all of them come I'll be in trouble. (Horn (2004) example 20(a))
>
> A. # If some *and possibly all* of my friends come to the party, I'll be happy, but if all of them come I'll be in trouble.
>
> B. If some *but not all* of my friends come to the party, I'll be happy, but if all of them come I'll be in trouble.

If it is true that no upper-bounded reading of *some* is generated in the first half of (11) because it is a conditional sentence (see example (8)), then *some* could be compatible with *all*. In the second half of the sentence, however, *all* is used after *but*, a conjunction which requires a contrast to license its use. Thus, when *all* is reached, there must be a contrast between *some* and *all*, in order to avoid the semantically odd (11a) reading. Horn (2004) suggests that when *all* is reached, some sort of repair operation must take place in order to retroactively create an upper-bounded reading of the word *some* (see also Geurts, 2009).

This is an experimentally testable prediction. Assuming repair operations take processing resources, they will also take time. Reading times are correlated with processing time, thus a hearer could be expected to take more time reading *all* and the words subsequent to it, than if they were reading the word in a context in which a contrastive set was already part of the hearer's model of the sentence. This prediction is the jumping off point for my experiment and for other research, and will be discussed more fully in section 1.3 and chapter 3.

First, however, there are several significant challenges, both to this prediction and to the Neo-Gricean approach to scalar implicature in general, which I will attempt to address below.

1.3 Challenges to the Classical Account

Neo-Griceans have followed Grice's lead in preserving a conservative definition of what is said—the purview of semantics—claiming the rest of what is conveyed or meant for pragmatics (Grice [1967] 1989; Bach, 2001). Significant challenges, however, have been raised to the Gricean and Neo-Gricean approach.

1.3.1 Relevance Theory

The most significant opposition to Neo-Gricean theory comes from the Relevance Theorists, who challenge the classical division between what is said and what is meant (Sperber and Wilson, 1986; Carston, 1988). Relevance Theorists argue that all of the Gricean Maxims can be replaced by a "Principle of Relevance": Contribute that which has the maximum ratio of contextual effects to processing cost (Sperber and Wilson, 1986). Applied to example (5), *Some of my friends are lovely people*, Relevance Theorists would argue that because *all* is a stronger term, it has more contextual effects, but the same amount of processing cost as *some*. Thus by not using *all*, the speaker means *not all*.

While Relevance Theory and Neo-Gricean theory have many significant differences, on this basic point the theories make rather similar predictions. Relavance theorists would argue, however, that the upper-bounded reading is not simply *implicated*, it actually becomes part of what is said, which they then call an *explicature* (Sperber and Wilson, 1986). This disrupts the classical view of the divide between what is said and what is meant as defined by Grice, returning much of what was considered non-semantic by Grice to the realm of explicit propositional content. This creats truth-conditional pragmatics, or semantics enriched by pragmatics (Recanati, 2001; 2010). For Relevance Theorists, pragmatics is not just read off the semantics, and it does not just contribute meaning beyond “what is said.
Rather, pragmatics actually influences “what is said” (Sperber and Wilson, 1986).

The most significant difference between these theories from the perspective of my experiment, is that Relevance Theory is defined based on cognitive principles and is defined so as to be a theory of hearer recovery and language processing rather than speaker meaning (Saul, 2002.) Because of this, the predictions of Relevance Theory often appear more testable in a psycholinguistic framework, leading experimentalists to believe they are pitting Relevance Theoretic predictions against Neo-Gricean ones even when as shown above, the predictions may actually be quite similar. Relevance theorists often claim to be attacking neo-Gricean theory, but in fact, argue against the strong-defaultist position of Levinson (2000) (discussed below). Many experimentalists perpetuate this misunderstanding, claiming to distinguish between Relevance theory and neo-Gricean theory in their studies (see for example, Noveck and Posada; 2003, Bott

and Noveck, 2004). I argue that the Levinsonian position should not be conflated with neo-Gricean theory in terms of its predictions regarding online processing of scalar implicature.

1.3.2 Levinson (2000)

While Levinson is often considered a Neo-Gricean, his position in his 2000 book is significantly different from that of other Neo-Griceans. The main difference is that Levinson (2000) argues that generalized scalar implicatures of the type I have been discussing (i.e. Example (5)) are, in fact, default inferences. This means that regardless of context, whenever the word *some* is used, the immediate response is to generate an upper-bound, and then, if the context does not support this upper-bounded reading, the hearer will cancel the upper-bound. Recall sentence (11):

> (11) If some of my friends come to the party, I'll be happy, but if all of them come I'll be in trouble. (Horn (2004) example 20(a))

According to Levinson (2000), *some* will automatically generate an upper-bounded reading in the antecedent of the conditional. If some later part of the sentence contradicted that reading, this upper-bound would then be canceled (by an effortful process). In (11), there are then two possible predictions: (a) the canceling operation could be slow enough that the upper-bound is still present when *all* is reached, requiring no extra processing on the part of the hearer, or (b) the upper-bound will be canceled and then regenerated at *all.* Recalling Grice's understanding of generalized conversational implicatures:

> A generalized conversational implicature can be canceled in a particular case. It may be explicitly canceled, by the addition of a clause that states or implies that the speaker has opted out, or it may be contextually canceled, if the form of utterance that usually carries it is used in a context that makes it clear that the speaker is opting out. (Grice, 1967: 39)

It is clear that Levinson's strong-defaultist position diverges quite sharply from Grice's. Thus conflating Levinson's position with a (neo)-Gricean one seems unfounded.

1.4 Theoretical positions in relation to experimental prediction

Despite the fact that previous researchers have claimed to pit neo-Gricean "defaultists" against the non-defaultist, context-sensitive position of Relevance Theorists, I believe this is both an over-simplification and a conflation of the actual landscape of theoretical positions.

In one camp are the defaultists: Levinson (2000) and also Chierchia (2004) who argues for a grammatical or syntactic approach to generalized conversational implicatures (GCIs). Both Levinson (2000) and Chierchia (2004) argue that GCIs are generated by default principles and are the preferred, although cancelable understanding of the utterance.[4] The default position predicts that a scalar implicature will be generated for the word *some* regardless of context, but will be canceled (effortfully) if a later part of the sentence contradicts the implicature.

Degen and Tanenhaus (2011) argue that simply differentiating between "defaultist" and "non-defaultist" positions is an overly simplistic way to characterize theoretical predictions regarding scalar implicature processing. They argue instead that the non-defaultist positions can be further divided between those who argue for context-driven approaches (see for example Katsos and Cummins, 2010) and those, like themselves, who argue for a constraint-based approach (Degen and Tanenhaus, 2011).

The context-driven approach suggests that sis are effortfully calculated only when they are necessary and not until after the context has already been evaluated (Katsos and Cummins, 2010).

The constraint-based approach advocated by Degen and Tanenhaus (2011) is an intermediate position. They argue that various constraints (local and global) interact to either facilitate or inhibit scalar implicatures. Scalar implicatures may be calculated rapidly and automatically in cases when the constraints sufficiently facilitate the implicature. In cases where the implicature is not sufficiently facilitated by the context, they may still be calculated slowly and effortfully, if it becomes necessary to do so later in the sentence. It is this latter position that seems most in line with the Gricean view of GCIs.

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[4] Geurts (2009) makes this point as well, although he employs a somewhat weaker understanding of default-ness.

1.5 Review of Experimental Literature

Recent research suggests that the effect of context on scalar implicatures is great enough to create measurable differences in reading times. Despite this, it is difficult to find any consensus on what that role is based on the existing experimental literature. It seems that the research tends to support a non-defaultist approach over a defaultist one (Bott & Noveck, 2004; Breheny et al., 2006; Huang and Snedeker, 2009, 2011). There are some studies, however, which support the defaultist position (Feeney et al., 2004; Grodner et al., 2010). There is even less evidence distinguishing between constraint-based and context-driven approaches.

The first studies on scalar implicature were mainly truth-value judgment experiments. One such study, done by Bott and Noveck (2004) tested participants' offline judgments of sentences involving scalar implicature. Participants were asked to read sentences such as "some elephants are mammals," and then respond true or false. In order to judge the sentence to be false, participants would have had to have generated a scalar implicature, or upper-bounded reading of the word *some*. A true judgment would indicate a strictly lower-bounded reading. Bott and Noveck (2004) also recorded participants' reaction times on the true-false judgment task and found that it took longer for participants to respond pragmatically.[5]

As Huang and Snedeker (2009) point out, however, this method has significant limitations. Reaction time studies do not provide an online measure of processing; they simply measure the final product. Thus, no information can be gleaned about stages of processing, or the time course of implicature generation. It is also difficult to determine whether a linguistic process has caused the delay or whether some other aspect of the task caused it. Feeney et al. (2004) suggest that differences in reading times found by Noveck and Posada (2003) reflect individual differences in processing strategies. Those who respond "pragmatically" (favor upper-bounded readings) may simply be more contemplative and thus take longer to respond. In their own study, Feeney et al. (2004) found no difference in reaction time between upper and lower bounded responses.

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[5] Another line of research has explored scalar implicature from a language acquisition perspective (Chierchia et al., 2001; Gualmini et al., 2001; Noveck, 2001; Papafragou and Musolino, 2002). These studies suggest that children are less likely than adults to respond pragmatically, and more willing to accept lower-bounded readings of scalar terms in contexts which could have pragmatic upper-bounds.

Other methodologies attempt to address the limitations of truth-value judgment studies. One such method, self-paced reading, provides an online measure of processing by tracking how long it takes participants to read each word or block of words in a sentence. Breheny et al. (2006) used self-paced reading to test the effect of context on generating scalar implicatures for the words *some* and *or*. The portion of the experiment on *some*, which is directly related to my study, used the following two types of sentences:

> (12) *Upper-bounded context:* Mary asked John whether he intended to host all his relatives in his tiny apartment. John replied that he intended to host some of his relatives. The rest would stay in a nearby hotel.
>
> (13) *Lower-bounded context:* Mary was surprised to see John cleaning his apartment and she asked the reason why. John told her that he intended to host some of his relatives. The rest would stay in a nearby hotel.
> (Breheny et al., 2006)

In the upper-bounded contexts, participants read the word *all* before the word *some* and were thus primed to read *some* as upper-bounded (so as to be in contrast with *all*). This is what makes (12) a so-called upper-bounded context. Breheny et al. (2006) found that participants took longer to read the phrase *some of his relatives* in the upper-bounded context than the lower-bounded context, but they took less time to read the phrase *the rest would stay* in the upper-bounded context. Breheny et al. (2006) took their findings to indicate that context can affect scalar implicature generation at an early stage of processing. They explain that in the upper-bounded context, participants indeed generated the scalar implicature earlier, whereas in the lower-bounded context participants had to generate the implicature when they reached *the rest*. This seems to align with Horn's (2004) view of scalar implicature generation in conditionals (although Breheny et al., 2006 interpret their results as a repudiation of the neo-Gricean position in favor of Relevance theory because they conflate Levinson (2000) with the neo-Gricean position in general). Again, Recall (11):

> (11) If some of my friends come to the party, I'll be happy, but if all of them come I'll be in trouble.

Horn (2004) argues that upon reaching *all*, a hearer will have to go back and perform a sort of repair operation to generate the scalar implicature after having already processed the word *some*.

Based on our understanding of conditionals (and downward entailing contexts in general) the conditional in the first half of (11) can be taken as similar to the lower-bounded context in Breheny et al. (2006).

Another study however, actually tests conditionals against declarative sentences for evidence that they do affect how scalar implicatures are processed. Hartshorne and Snedeker (*submitted*) compare the following sentences:

(14) If Mary ate some of the cookies before breakfast, then the rest are in the cookie jar.
(15) Mary ate some of the cookies before breakfast, and the rest are in the cookie jar.

They compared reading time both at the quantifier, *some*, and later in the sentence, in the window including and following *the rest.* Unlike Breheny et al. (2006), Hartshorne and Snedeker (*submitted*) did not find any delay at the quantifier in implicature-supporting (declarative) contexts. They did however find a significant delay in the final window of the sentence after *the rest*. Hartshorne and Snedeker (*submitted*) conclude that this finding is evidence of a Horn-esque repair operation following the rest, but that context does not affect scalar implicature processing at as early a stage as Breheny et al. (2006) suggest. They argue that scalar implicature generation is a slow process, taking about 900 ms following the quantifier to be realized.

This explanation, however, is not necessarily the only one that fits Hartshorne and Snedeker's data. In another self-paced reading experiment, Politzer-Ahles and Fiorentino (2013) use sentences similar to Breheny et al.'s (2006) stimuli. Like Hartshorne and Snedker (*submitted*) they did not find evidence of any delay at the quantifier, *some*, in either context. Rather than posit that this means scalar implicature generation is always a slow process however, Politzer-Ahles and Fiorentino (2013) take their findings as evidence for the constraint-based approach of Degen and Tanenhaus (2011). They argue that the lack of delay at the quantifier suggests that certain aspects of context can make scalar implicature generation rapid, automatic, and effortless enough to not be detectable in reading times. In other sentences, where the implicature is not sufficiently supported, it can still be generated, but it must be done slowly, effortfully, and only if needed, explaining the delay at *the rest*.

A similar back and forth has occurred in a different line of research. Huang and Snedeker (2009) examine scalar implicature processing using a methodology called the "visual-world paradigm." They used eye-tracking to follow participants' gazes as they listened to instructions asking them to manipulate objects in a visual display. For example, participants would hear instructions asking them to "point to the girl with some of the socks" while looking at a display with four different scenes. Eye-movements have been found to be a reliable and closely time-locked measure of comprehension (Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). Huang and Snedeker (2009) thus compare the percentage of looks to the target display to looks to other displays as participants listen to the sentence. They found that participants were slower to differentiate the target scene from the distractor when instructions used the word *some* as compared to when the instructions used the word *all, two, or three*. In a follow-up experiment, they found that participants were eventually able to use scalar implicature (an upper-bounded interpretation of *some*) to differentiate displays. Participants were not, however, able to do this until at least 800 ms after the quantifier was heard (Huang and Snedeker, 2009). They take this as evidence that scalar implicature generation is a slow and effortful process.

Grodner et al. (2010), however, dispute these findings. Performing an extremely similar visual-world paradigm experiment, Grodner et al. (2010) found that with slightly different stimuli, convergence on the target scene was just as fast for *some* as it was for *all* or for cardinal numbers. They take this as evidence that scalar implicature may, in fact, be processed rapidly in some cases. Their results seem to support the constraint-based theory of Degen and Tanenhaus (2011); though perhaps unsurprisingly, Tanenhaus was one of the authors of Grodner et al. (2010).

The techniques of experimentation are blunt and imperfect, and confounds abound in neuro and psycholinguistic research. So far, there is little consensus in the field, and there is experimental evidence on many sides of the theoretical debate. It is with this sobering knowledge in mind that I approach my own experiment.

2. Prosody and Psycholingustic Experimentation

2.1 Prosody and Pragmatics, an overview

Apart from the psycholinguistic research on scalar implicature, a large body of research has explored the role of prosody in language comprehension. Price et al. (1991) demonstrate that though prosodic structure and syntactic structure are distinct, prosodic cues can be used to disambiguate syntactic structure. Shattuck-Hufnagel and Turk (1996) provide a thorough and foundational review of the literature on prosodic theory and psycholinguistics research. They suggest that while aspects of grammatical structure constrain the possible prosodic choices a speaker can make, it does not fully predict the prosody of the utterance (Shattuck-Hufnagel and Turk, 1996). This means that speakers may make choices as to what prosodic structure to use for an utterance, and these choices may reflect other aspects of the speaker's intended meaning, including pragmatic implicatures.

Prosody has been shown to be important in many aspects of language use and processing. Gravano et al. (2008) find that prosodic contour plays a significant role in assessments of speaker certainty. Another study, which examines the role of prosody on pragmatics in actual conversations rather than speech prepared for experimental use, found that consistent prosodic markers correlate with specific pragmatic uses of repetition in conversation (Curl et al., 2006). Curl et al. (2006) point out the differences between the language used in laboratory experiments and the language They did not find, however, that prosody itself had any effect on participants understanding of utterances (Curl et al., 2006).

In an online, eye-tracking study of the effects of prosody on comprehension, Snedeker and Trueswell (2003) found that prosody plays a significant role in online comprehension. Speakers chose to produce effective prosodic cues to disambiguation when describing a scene that could have been consistent with multiple interpretations of an ambiguous phrase. Not only that, listeners were also able to use prosodic information to disambiguate scenes, and the prosodic information influenced listeners even before the onset of the ambiguous phrase. This suggests that speakers use prosody to communicate meaning that would not otherwise be clear in the utterance, and listeners use this information rapidly in online sentence processing. Schafer et al. (1997) also find that prosody affects comprehension at early stages of processing and that different types of prosodic effects and different levels of the prosodic hierarchy affect

comprehension in different ways, suggesting a complex relationship between prosodic structure and meaning structure.

2.2 Emphasis and Scalar Implicature

Emphasis is defined by several different prosodic features: pitch, volume, and durational effects. Stressed or emphasized words tend to be louder, have a raised fundamental frequency, and stressed syllable tend to have longer duration (Lieberman, 1960; Morton and Jassem, 1965). Prosodic emphasis that picks out or distinguishes a particular word in a sentence is known as "contrastive focus" a type of intonational focus and is generally marked by a L+H* accent (Pierrehumbert & Hirschberg, 1990) with a steep pitch slope (Bartels & Kingston, 1994). Sedivy (2003) offers the example that the utterance "JOHN smokes cigars" expresses a meaning beyond the literal, whether that is a correction of a mistaken assertion, a response to a who-question, a contrast between John's habits and other people's habits, or some other contrast in knowledge.

There is some evidence to suggest that contrastive focus can be used to facilitate processing and comprehension. Eberhard et al. (1995) performed an eye-tracking study in which participants were instructed (for example) to "touch the large/LARGE red square." The study reports that participants were able to more quickly distinguish the target object from the distractor when intonational focus was used in the instructions. (This effect was contingent on the information that was focused being sufficient to disambiguate the displays in the first place). In a similar eye-tracking study, however, Sedivy et al. (1999) failed to find this processing advantage for instructions using intonational focus.

Emphasis, stress, or focus are often cited in the pragmatics literature as being necessary for or aiding in achieving a certain understanding of an utterance. For example, Milsark (1977: 172) argues that the phonetically reduced, unmarked, unstressed form of the word *some*, which he calls "sm" does not carry extra meaning beyond what is said (although he characterizes the implicature as an entailment, which has been shown to be an overly strong an analysis). His characterization of "sm" as a reduced form aligns with the literature on prosodic markers of non-stressed items (characterized by vowel reduction and shorter duration (Morton and Jassem,

1965)). If Milsark is correct in this distinction (though not in his characterization of it as entailment), then prosody would indeed play a role in scalar implicature generation.

Example sentences citing the importance of emphasis abound in the theoretical literature. The following are just a subset of those examples.

Ward and Hirschberg (1985), Ex (2):

(16) A: Legumes are a pretty poor source of vitamins.
B: No. Legumes are a GOOD source of vitamins.

Hirschberg (1991):

(17) A: So, you say you don't have two friends to cosign this loan?
A. B: No, I don't have THREE friends.
B. B: Well, I don't have \three/ friends.

All-caps in (a) represents "contrastive stress" and \/ in (b) represents "fall-rise" intonation. Hirschberg orthographically represents two different prosodic contours and asserts that these contours have different pragmatic effects.

Prosodic emphasis is also represented in examples dealing specifically with scalar implicature. Ippolito (2011) argues that the following sentence is problematic:

(18) #Mary ate all of the cookies but John wishes she had eaten some of them.
(Ippolito, 2011 example (10))

But (10), she argues, improves substantially by either including an overt *only*, or by using contrastive stress to mark *some* (i.e. SOME, see Ippolito, 2011, example (21)). A similar example is also seen in Horn (2012):

(19) You didn't eat SOME of the cookies, you ate ALL of them.

Geurts and van Tiel (2012) examine scalar expressions in embedded contexts, and refer to the phenomenon I have been calling scalar implicature as “Upper Bounded Construals” or UBCs, arguing that in embedded contexts they may either be implicatures or truth-conditional

effects. They argue that truth-conditional narrowing is distinct from quantity implicature, but that it can also be pragmatically defined. Further more these narrowing, embedded UBCs, are always marked (meaning they always have special prosodic emphasis). Elsewhere they argue that narrowing must be helped by contrastive stress, citing examples from Geurts (2010:196):

(20) He isn't RICH, he's RICH.

In this case Geurts (2010) uses two different graphical manipulations, small caps and all caps, to illustrate different levels of contrastive stress. This stress is not merely a feature of this type of sentence, but actually crucial to the felicitousness and comprehensibility of the utterance (Geurts, 2010; Geurts and vantiel, 2012).

2.3 Visual representations of prosodic features (ALL-CAPS)

It is well established in the field of prosody experimentation that graphical manipulations in written speech can be used to elicit prosodic effects (Turk and Shattuck-Hufnagel, 2000; Cho, 2004; Byrd, Krivokapić, and Lee, 2006; White and Turk; 2010). Both Turk and Shattuck-Hufnagel (2000) and White and Turk (2010) (among others) use capitalization to elicit emphasis in tasks that require participants to read sentences aloud. Other studies have used different graphical manipulations; for example, Cho (2004) uses bold text, and Byrd, Krivokapić, and Lee (2006) use underlining. Regardless of the particular manipulation used, however, it is uncontroversial in the field of prosody research that graphical manipulations successfully elicit prosodic emphasis.

While my experiment has not asked participants to read sentences aloud, I am fairly confident that the manipulation evoked the intended effect, and I also explained to participants how the capitalization should be read. Not only is this manipulation attested in prosody literature, it is used extensively in the theoretical pragmatics literature to show emphasis or focus in example sentences (see section 2.3, above). Finally, in the age of the Internet in which so much of our daily communication takes place digitally, on Twitter, Facebook, email, Gchat, in text messages, and on a myriad of other websites, the written word is being used in informal communication in more and more ways. Given the limited ability to express register and tone in

these media, capitalization plays an incredibly important role in marking emphasis or emotion, and even disambiguating meaning.[6]

Additionally, evidence from work on reading and teaching reading suggests that using all capitals is an effective way to highlight prosodic emphasis or stress. This has been demonstrated in the readings of heteronyms, words that are spelled the same way but have different meanings and are pronounced with emphasis on different syllables (Mitchell, 2011). For example, the words CONtent and conTENT can reliably be differentiated using all-caps to mark the desired emphasis within the word.

There is, of course, a separate question as to whether emphasis when it is read is processed in the same way as when it is heard. The manipulation in my experiment cannot address this issue.

3. The Present Study

This project seeks to zoom in on the way our brains negotiate the complex landscape at the intersection of what one says, how one says it, and what one really means.

In the present study, I investigate online sensitivity to prosodic information in scalar implicature processing, borrowing many elements from Hartshorne and Snedeker's design but using a visual-prosodic rather than contextual manipulation. Rather than simply examining the effect of downward-entailing contexts on online scalar implicature generation, I focus on the combined effect of prosody and context on the processing of quantifiers. Working off the linguistic analyses proposing that scalar implicatures are dispreferred[7] in downward entailing

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6 Recently, the importance of capitalization in disambiguating meaning in twitter hashtags (which do not use spaces to mark word breaks) was illustrated by the small uproar over "#nowthatcherisdead." The hashtag referred to the death of Britain's "Iron Lady," Margaret Thatcher, but Cher fans across the internet temporarily panicked that the pop icon, Cher, had died.
"Hashtag #nowthatcherisdead Confuses Cher Fans," Storify by Wall Street Journal, April 8, 2013, Accessed April 18, 2013. http://storify.com/wsj/hashtag-nowthatcherisdead-confuses-cher-fans

[7] As I discuss in section *1.2.3*, it is not necessarily that scalar-implicatures are blocked or are not generated at all here, scales may in fact be reversed, but the implicature found in a non-DE context will not be found in this example.

contexts (1989: 233-34) and the experimental evidence to this effect (Hartshorne and Snedeker, *submitted*), I investigate whether a visual cue to prosodic emphasis (all-caps) can facilitate scalar implicature generation even in cases where it is the otherwise dispreferred reading (i.e. conditional sentences).

If Degen and Tanenhaus (2011) are correct in their constraint-based theory of scalar implicature generation, and if prosodic emphasis can serve as one of those constraints or facilitating items, then it might be the case that emphasis would facilitate scalar implicature in otherwise contextually non-facilitating contexts. On the other hand, if this facilitation is not found, Degen and Tanenhaus (2011) may still be correct, but prosody might not be a relevant constraint, or it might not be strongly weighted enough to overwhelm other contextual effects.

Participants read matched non-emphasized (21a) and emphasized (21b) sentences word-by-word in a self-paced reading experiment. The differences between my non-emphasized (21a) and emphasized (21b) contexts were limited to the form of one word: the all-caps "SOME" in (21b). The non-emphasized conditional sentence has been shown by Hartshorne and Snedeker (*submitted*) to be an SI-nonsupporting context. I tested to see whether the emphasized condition supports or facilitates scalar implicature. If a visual cue to prosodic emphasis has an early effect on scalar implicature processing – and if scalar implicature calculation can be computationally costly and lead to longer reading times (RTs) (Bott & Noveck, 2004; Breheny et al., 2006) – then I would expect longer RTs for the quantifier region (*some/SOME of her chores*) in (21b) relative to (21a), though the novelty of seeing a word in all-caps may make it difficult to find a linguistically-relevant effect. If scalar implicature generation is facilitated or more rapid in the emphasized condition, I would expect shorter reading times at *the rest must be* for (21b) relative to (21a).

(21a) *Non-Emphasized:* If Alexa did some of her chores very early this morning, then the rest must be completed this evening.

(21b) *Emphasized:* If Alexa did SOME of her chores very early this morning, then the rest must be completed this evening.

While the simplicity of this manipulation removes many potential confounds, any difference in reading time between (21a) and (21b) could still reflect differences in processing written words in the standard fashion versus in all-caps (though I believe the prevalence of the use of all-caps

in day to day written communication makes this less problematic, see section 2.3). Accordingly, I have included many filler items that use all-caps in different parts of the sentences.

(21c) *Filler*: If Alexa carried several of the boxes to her new apartment, then the FURNITURE should be moved by truck.

3.1 Method

3.1.1 Participants. Thirty Yale University undergraduates who were native English speakers participated in this experiment (19 female; 18-22 y.o.). All participants completed the experiment and all reached acceptable accuracy levels on the comprehension questions that followed each sentence.

3.1.2 Materials. 32 experimental items were created, with two versions of each item; for example, (21a) and (21b). For each of these pairs, two filler sentences were created (64 total) which were similar in the first clause, but did not include *the rest* in the second clause so that the upper-bounded reading would not be predictable. Filler items also included all-caps words in different places, and some sentences used quantifiers other than *some* in the first clause (see (21c)). Finally, I also included filler that had a continuation that did not re-mention the original noun set. Experimental items were divided into two lists according to a Latin Square design. 15 participants saw one list, 15 saw the other. Each list had half of the items in the non-emphasized (some) condition and half in the emphasized (SOME) condition. (See Appendix A for full items list). Each item had a related Yes/No comprehension question, which participants had to answer after reading the sentence. Questions were piloted to make sure participants could answer them at acceptable accuracy levels (pilot results: 92/96 and 90/96 correct). An error in the items file caused one question not to display for three out of thirty subjects. This error did not affect the experimental items, so data from the associated sentence was still included.

3.1.3 Procedure. Each participant was randomly assigned to list A or list B (and each list was presented 15 times). Each participant was presented with 32 critical sentences (half in the non-emphasized (some) condition and half in the emphasized (SOME) condition) and 64 fillers. The order of these 96 sentences was randomized for each participant.

Sentences were presented one word at a time in the center of the screen using the Linger experimental software developed by Doug Rohde (available online at http://tedlab.mit.edu/~dr/Linger/). Participants pressed the spacebar to advance to the next word. They answered comprehension questions after all of the trials, ensuring that they were paying attention. Participants were instructed prior to the experiment that sometimes they would see a word in all-caps, and that this should be understood as the kind of emphasis people sometimes use in speech. They were then given an example: pointing first to one chair and then another I would say "not that chair, THAT chair." Participants were asked to confirm that they understood and were familiar with the use of all-caps in this way. The experiment was conducted on my laptop in a quiet room. Participants were given headphones to block out any other noise.

3.2 Results

First, word-length was regressed out using a mixed-effects regression model with a by-subject random intercept and slope using the standard package lme4 in R. The model predicted This was to make sure that any reading time (RT) effects were not simply due to word-length. The residuals of this regression model, which predicted log-transformed RTs from lengths, were then analyzed further.

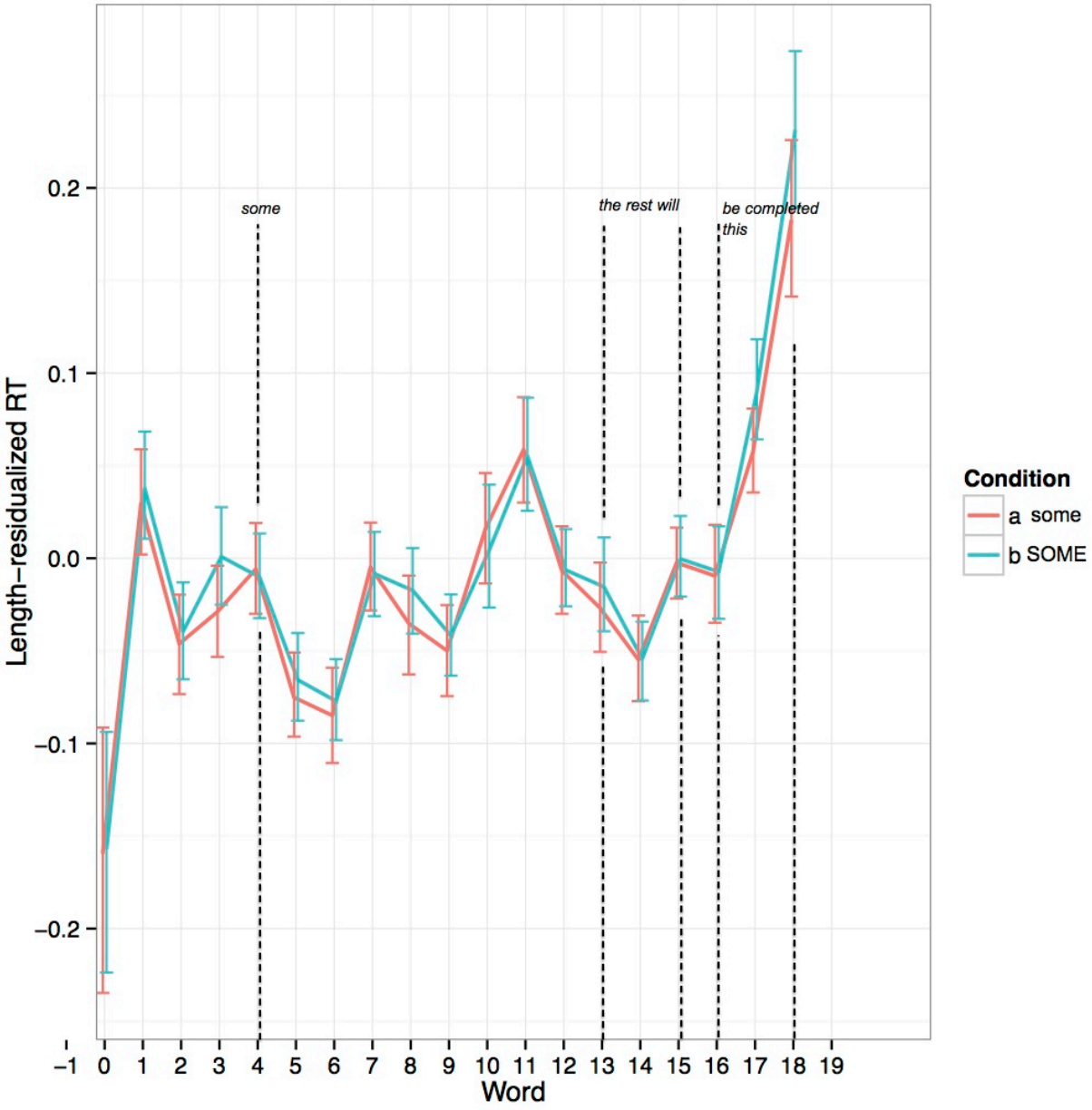

Figure 1: Length-residualized word-by-word mean reading times. Error bars are bootstrapped 95% confidence intervals.

Figure 1 shows length-residualized log(RT) word-by-word for each condition. The data were then divided into three regions of interest: "some," "the rest will," and "be completed this" (illustrated by dashed lines in Figure 1). The last word was discarded because of noisiness typical of sentence-final words.

Results (Table 1) were analyzed using mixed-effects models with a by-subject random intercept and slope and a by-item random intercept because a model with a by-item slope did not

converge (Barr et al., 2013). Analysis was performed in R using the lme4 package, and p-values are approximate and based on the Wald statistic—treating the t statistic as if it came from a normal distribution. Accuracy on the comprehension questions was high, given that they were designed to be difficult and thus promote attention (M=93.6%). No data was excluded for lack of accuracy. The difference in RT between the emphasized (SOME) and non-emphasized (some) conditions did not reach statistical significance ($p<.05$) in any of the regions of interest. The difference in reading time between *SOME* and *some* (it seems to have taken participants slightly longer to read the emphasized word) is the closest to statistically significant. I suspect that this is simply because of the graphical manipulation (see discussion below), and I am wary of taking this as evidence early scalar implicature generation. Additionally, reading times for the remaining two windows both appeared to be slightly *longer* in the emphasized condition (though not statistically significantly so), which is the opposite of the result my hypothesis would predict. There are several possible reasons for this, which I will discuss below.

Results

	Some/SOME	The rest will	Be completed this
Estimated difference, cond b-cond a (Standard Err)	0.0300 (0.0177)	0.0124 (0.0394)	0.0362 (0.0424)
T-value/p-value	1.70 (p=.09)	0.32 (p=.75)	0.86 (p=.39)

Table 1. Estimated difference of residualized log(RT), condition b (SOME) – condition a (some), for three regions, with t-values and p-values

3.3 Discussion and Future Directions

The results of this experiment are inconclusive. While the difference in reading time between *SOME* and *some* did not reach true statistical significance ($p<0.05$) it did seem to take participants longer to read the word in all-caps. While this could be a result of increased processing indicating scalar implicature generation the emphasized quantifier, it is also quite likely that the delay is simply caused by the novelty of seeing a written word in all-caps. Even

though all-caps is common in every-day chatting, texting, and internet-mediated speech, it is still different from all the other words in the sentence, and that alone could be enough to cause increases in reading times. A study of the effect of various features on email comprehension and readability found that emails written entirely in all-caps did take longer to read than their lower-case and mixed-case counterparts (Greer et al., 2005). Future research should include a way to measure the reading time differences between all-caps words and lower-case words within otherwise standard sentences.

I did not find any significant difference in reading time at *the rest must be*. There are several potential explanations for this result. First and foremost, self-paced reading is not a very sensitive method. It is possible that I did not have enough subjects or enough items to achieve statistical significance. The fact that there were no trends toward longer reading times for the non-emphasized condition at *the rest must be*, indicates, however, that there may be additional reasons for the null result. One potential explanation is that my experiment was too predictable, and that participants simply assumed that *some* was necessarily upper-bounded despite the filler sentences. In order to account for this it might be good to run the experiment with even more filler, perhaps including some that are substantially different from the other items.

One way to assess whether the conditional was producing the intended blocking effect would have been to have another experimental condition that began with a declarative rather than a conditional, thereby replicating Hartshorne and Snedeker (*submitted*). This would have allowed me to confirm that participants were, in fact, reading *the rest must be* more slowly in the non-capitalized conditional condition (that there was a measurable effect of the lack of facilitation of scalar implicature in that condition). In the initial version of this experiment I included this additional manipulation, but the experiment ended up being too long, leaving subjects extremely fatigued and irritated, and limiting my ability to find willing participants. The added complexity also made the resulting data difficult to analyze. This led me to rewrite my stimuli and simplify the experiment.

There are also possible theoretical explanations for the lack of a difference in reading time between the conditions. One potential explanation is simply that my hypothesis is wrong, and emphasis either does not affect scalar implicature generation, or the all-caps visual cue was not sufficient to elicit this effect. My results need not be taken, however, as a complete repudiation

of my original hypothesis. Another potential explanation, is that if Degen and Tanenhaus's (2011) constraint-based theory is correct, then perhaps emphasis is simply not a heavily weighted enough factor to overcome the upper-bound non-supporting effect of the conditional sentence. In this case my results would be showing that the scalar implicature was calculated late in both conditions, and that there was simply no advantage afforded by having *some* in all-caps. Having a semantically upper bounded control (i.e. *only some*) as in Hartshorne and Snedeker (*submitted*) (and as in my first experimental attempt) would have helped determine whether or not this was the case.

While the results of this study do not provide much clarifying information, they do point towards important areas of future analysis and research. It would potentially be informative to run further statistical analysis on my current data set to identify any systematic trends in the data that I have not predicted. I do not currently posses the knowledge of statistics required to perform such analyses, but as I continue to learn, I will reexamine this data.

Perhaps more enlightening, however, would be to run the experiment with a slightly different set of materials. If I am correct in thinking that the implicature non-supporting effect of the conditional simply overwhelms any effect of the all-caps manipulation, then the vignette-style stimuli of Breheny et al. (2006) and Politzer-Ahles et al. (2013) might be a better paradigm for investigating this effect. My next step will be to run a version of my experiment using a variation on the materials from Politzer-Ahles et al. (2013). (20a) and (20b) are from Politzer-Ahles et al. (2013), and (20c) is my manipulation ("/" marks off sections of text that were presented simultaneously), and (20a-c) all follow in the Breheny et al. (2006) model.

(22a) *Some vignette*: Mary was preparing to throw a party for John's relatives. / She asked John whether (all of them/any of them) were staying in his apartment. / John said that / some of them / were. / He added / that / the rest / would be / staying / in a hotel.

(22b) *Only some vignette*: Mary was preparing to throw a party for John's relatives. / She asked John whether (all of them/any of them) were staying in his apartment. / John said that / only some of them / were. / He added / that / the rest / would be / staying / in a hotel.

(22c) *SOME vignette*: Mary was preparing to throw a party for John's relatives. / She asked John whether (all of them/any of them) were staying in his apartment. / John said that / SOME of them / were. / He added / that / the rest / would be / staying / in a hotel.

(22a-c) each have a SI-supporting version (all of them) and an SI-nonsupporting version

(any of them). It will be interesting to see if the emphasis manipulation is more natural in the context of the vignettes than in the conditional sentences. If emphasis does help facilitate scalar implicature generation, then I would expect to find similar reading times at *the rest* for the *SOME* and *only some* conditions in the implicature non-supporting contexts. If emphasis is a more weakly weighted constraint or implicature facilitating effect, then it might be that reading times at *the rest* are shorter than for the *SOME* condition but not as short as the *only some* condition. It would also be interesting to see whether the effect is additive; in other words, if, in the SI-supporting context, emphasis provides an extra facilitation for implicature generation, leading to an even shorter reading time at *the rest*. If the Degen and Tanenhaus (2011) hypothesis that in implicature-supporting contexts SI generation is immediate and cost free, then one would not expect to find an additive effect in a context that already supports SI generation. If, however implicature generation is always a somewhat effortful and costly process (Katsos and Cummins, 2010), then it might be possible to find such an additive effect.

If this further study also yields a null result, then my next step will be to abandon self-paced reading and switch to a different methodology. As I have noted, self-paced reading is a blunt and artificial tool. It is not especially well suited to researching prosodic effects given that prosody is generally an auditory phenomenon and self-paced reading employs the visual mode. It is possible that the all-caps manipulation simply does not properly capture the emphasis that theory and intuition both suggest is extremely important in recovering what is *meant* and not merely said in an utterance (the realm of pragmatics). The visual world paradigm (Huang and Snedeker, 2009 and 2011, Grodner et al., 2010) may be a better method to use because the instructions to participants are presented aurally. Such a study would be based on the paradigm used by Huang and Snedeker (2009). Participants would listen to instructions asking them to point to one display out of four possible displays. Eye-tracking would be used to determine the point during the course of the instructions at which participants begin to fixate on the target display at above chance levels (indicating comprehension of the instructions to the degree necessary for disambiguation). Instead of simply testing sentences containing *some*, *all*, *two*, and *three*, however, I would also record an emphasized version of *some* (employing prosodic effects of pitch, loudness, and duration). If participants are able to focus on the target display earlier in the *some*+emph condition than in the regular *some* condition, this would indicate that prosodic emphasis does facilitate scalar implicature generation.

On the one hand, a null result is disappointing. It means that either my hypothesis is wrong, or I have not performed an experiment that tests it carefully enough. Still, this experiment provides a starting point for future research on the neuro- and psycholinguistics of the prosody-pragmatics border. I have learned a great deal about linguistic experimentation and its pitfalls. I have also identified several possible issues with the present experiment and next steps to take to learn more. I do not believe my results should be taken as evidence that prosody does not play a role in scalar implicature generation, but rather that more research and different modalities may be required to uncover that effect.

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Appendix A: Item List

1 a
If Alexa did some of her chores very early this morning, then the rest must be completed this evening.
? Does Alexa only do chores in the morning? N
1 b
If Alexa did SOME of her chores very early this morning, then the rest must be completed this evening.
? Does Alexa only do chores in the morning? N

2 a
If Avery planted some of the seeds in the back yard, then the rest will be sown out front.
? Will Avery only plant seeds in the back yard? N
2 b
If Avery planted SOME of the seeds in the back yard, then the rest will be sown out front.
? Will Avery only plant seeds in the back yard? N

3 a
If Brittany spilled some of the wine on the nice carpet, then the rest must be staining the tablecloth.
? Did Brittany spill water on the wood floor? N
3 b
If Brittany spilled SOME of the wine on the nice carpet, then the rest must be staining the tablecloth.
? Did Brittany spill water on the wood floor? N

4 a
If Brian caught some of the robbers in his jewelry store, then the rest must have escaped too quickly.
? Was there more than one robber in Brian's store? Y
4 b
If Brian caught SOME of the robbers in his jewelry store, then the rest must have escaped too quickly.
? Was there more than one robber in Brian's store? Y

5 a
If Carlos finished some of the projects before he left work, then the rest must be done at home.
? Will Carlos have a coworker finish his work for him? N
5 b
If Carlos finished SOME of the projects before he left work, then the rest must be done at home.
? Will Carlos have a coworker finish his work for him? N

6 a
If Carmen invited some of her friends to the dinner party, then the rest must be feeling left out.
? Is Carmen having a party? Y
6 b
If Carmen invited SOME of her friends to the dinner party, then the rest must be feeling left out.
? Is Carmen having a party? Y

7 a
If Daniel solved some of the problems on the problem set, then the rest must be finished between classes.
? Is Daniel working on a research paper? N
7 b
If Daniel solved SOME of the problems on the problem set, then the rest must be finished between classes.
? Is Daniel working on a research paper? N

8 a
If Devin watched some of the movies for her film class, then the rest must be viewed this weekend.
? Does Devin study film? Y
8 b
If Devin watched SOME of the movies for her film class, then the rest must be viewed this weekend.
? Does Devin study film? Y

9 a
If Edward grazed some of the cattle before school this morning, then the rest must be fed this afternoon.
? Was it pigs that Edward is feeding? N

9 b
If Edward grazed SOME of the cattle before school this morning, then the rest must be fed this afternoon.
? Was it pigs that Edward is feeding? N

10 a
If Ella checked some of her homework for errors before bed, then the rest must be checked before school.
? Is Ella a student? Y
10 b
If Ella checked SOME of her homework for errors before bed, then the rest must be checked before school.
? Is Ella a student? Y

11 a
If Finn toured some of the colleges before the term's end, then the rest must be visited over vacation.
? Is Finn busy touring museums? N
11 b
If Finn toured some of the colleges before the term's end, then the rest must be visited over vacation.
? Is Finn busy touring museums? N

12 a
If Finola contacted some of the donors for the annual drive, then the rest must be called this week.
? Is Finola trying to raise money? Y
12 b
If Finola contacted SOME of the donors for the annual drive, then the rest must be called this week.
? Is Finola trying to raise money? Y

13 a
If Garrett contributed some of the funds to build the library, then the rest must be raised this month.
? Were all the funds for the library raised last month? N
13 b
If Garrett contributed SOME of the funds to build the library, then the rest must be raised this month.
? Were all the funds for the library raised last month? N

14 a
If Galya repaired some of the cars before the shop closed, then the rest must be fixed after hours.
? Does Galya work at an autoshop? Y
14 b
If Galya repaired SOME of the cars before the shop closed, then the rest must be fixed after hours.
? Does Galya work at an autoshop? Y

15 a
If Hector took some of the trash out before spring break, then the rest must be removed by maintenance.
? Is Hector leaving for winter break? N
15 b
If Hector took SOME of the trash out before spring break, then the rest must be removed by maintenance.
? Is Hector leaving for winter break? N

16 a
If Holly skimmed some of the books that the professor assigned, then the rest must be read over break.
? Might Holly have homework to do over break? Y
16 b
If Holly skimmed SOME of the books that the professor assigned, then the rest must be read over break.
? Might Holly have homework to do over break? Y

17 a
If Ian brought some of the puppies home from the shelter, then the rest must be given away soon.
? Can Ian keep all of the puppies? N
17 b
If Ian brought SOME of the puppies home from the shelter, then the rest must be given away soon.
? Can Ian keep all of the puppies? N

18 a
If Isabel assessed some of the candidates for the new position, then the rest must be interviewed before Friday.

? Is Isabel planning to see all the candidates before the end of the day on Friday? Y
18 b
If Isabel assessed SOME of the candidates for the new position, then the rest must be interviewed before Friday.
? Is Isabel planning to see all the candidates before the end of the day on Friday? Y

19 a
If Jackson sold some of the cakes at the bake sale, then the rest will be distributed for free.
? Were all of Jackson's cakes given away for free? N
19 b
If Jackson sold SOME of the cakes at the bake sale, then the rest will be distributed for free.
? Were all of Jackson's cakes given away for free? N

20 a
If Jacqueline evaded some of the cops who were pursuing her, then the rest will be lying in wait.
? Is Jacqueline being chased by the police? Y
20 b
If Jacqueline evaded SOME of the cops who were pursuing her, then the rest will be lying in wait.
? Is Jacqueline being chased by the police? Y

21 a
If Kareem designed some of the posters for next month's event, then the rest must be created next week.
? Does Kareem have two more weeks to finish creating the posters? N
21 b
If Kareem designed SOME of the posters for next month's event, then the rest must be created next week.
? Does Kareem have two more weeks to finish creating the posters? N

22 a
If Katrina covered some of the furniture with the plastic tarps, then the rest must be protected with canvass.
? Does Katrina have furniture covers that are not plastic? Y
22 b
If Katrina covered SOME of the furniture with the plastic tarps, then the rest must be protected with canvass.
? Does Katrina have furniture covers that are not plastic? Y

23 a
If Leandro returned some of the calls on his answering machine, then the rest must be answered later tonight.
? Is Leandro's answering machine empty? N
23 b
If Leandro returned SOME of the calls on his answering machine, then the rest must be answered later tonight.
? Is Leandro's answering machine empty? N

24 a
If Lucia organized some of the textbooks in her math classroom, then the rest must be arranged after school.
? Was the math classroom the place where Lucia was arranging textbooks? Y
24 b
If Lucia organized SOME of the textbooks in her math classroom, then the rest must be arranged after school.
? Was the math classroom the place where Lucia was arranging textbooks? Y

25 a
If Marcus got some of the records by asking for them, then the rest must be obtained by subpoena.
? Will Marcus steal the records he needs ? N
25 b
If Marcus got SOME of the records by asking for them, then the rest must be obtained by subpoena.
? Will Marcus steal the records he needs ? N

26 a
If Mallory closed some of the windows because of the rain, then the rest must be sealed very soon.
? Does Mallory want to protect the house from the rain? Y
26 b
If Mallory closed SOME of the windows because of the rain, then the rest must be sealed very soon.
? Does Mallory want to protect the house from the rain? Y

27 a

If Nikolai examined some of the patients who had ear infections, then the rest will be treated after lunch.
? Will Nikolai examine and treat all the patients before lunchtime? N
27 b
If Nikolai examined SOME of the patients who had ear infections, then the rest will be treated after lunch.
? Will Nikolai examine and treat all the patients before lunchtime? N

28 a
If Neha replaced some of the dishes that she accidentally broke, then the rest must be fixed after pay-day.
? Is Neha replacing the dishes she broke? Y
28 b
If Neha replaced SOME of the dishes that she accidentally broke, then the rest must be fixed after pay-day.
? Is Neha replacing the dishes she broke? Y

29 a
If Omar woke some of the students in time for class, then the rest will be roused too late.
? Are the teachers the ones who Omar has to wake for class? N
29 b
If Omar woke SOME of the students in time for class, then the rest will be roused too late.
? Are the teachers the ones who Omar has to wake for class? N

30 a
If Olivia hung some of the paintings before her lunch break, then the rest must be positioned before two.
? Does Olivia have a deadline to meet? Y
30 b
If Olivia hung SOME of the paintings before her lunch break, then the rest must be positioned before two.
? Does Olivia have a deadline to meet? Y

31 a
If Pedro sang some of the songs to the kindergarteners earlier, then the rest will be played before naptime.
? Did Pedro sing songs to the second graders? N
31 b
If Pedro sang SOME of the songs to the kindergarteners earlier, then the rest will be played before naptime.
? Did Pedro sing songs to the second graders? N

32 a
If Polly stole some of the money in the bank account, then the rest must be transferred for protection.
32 b
If Polly stole SOME of the money in the bank account, then the rest must be transferred for protection.
? Is Polly's a thief? Y

Filler 1 a
If Alexa carried several of the boxes to her new apartment, then the FURNITURE should be moved by truck.
? Did Alexa carry all of her boxes by herself? N

Filler 2 a
If Avery baked SOME of the cupcakes for the party tomorrow, then the cookies must be made soon also.
? Is Avery baking desserts for the party? Y

Filler 3 a
If Alexa stole some of the money from the checking account, then another group of young thieves did too.
? Was it only Alexa who stole from the bank account? N

Filler 4 a
If Avery grabbed FOUR of the candies out of the bowl, then the chocolates are still in there.
? Were there more than four items in the bowl before Avery took some? Y

Filler 5 a
If Brittany folded most of the shirts in her dresser drawer, then the pants might fit in the drawer too.
? Does Brittany hang up all her shirts in the closet? N

Filler 6 a

If Bryan kneaded SOME of the dough for the bread loaves, then the REST must be rising in the fridge.
? Is Bryan making a cake? N

Filler 7 a
If Brittany cleared some of the PLATES from the breakfast table, then the silverware must be cleared soon too.
? Did Brittany clear some of the plates before clearing the silverware? Y

Filler 8 a
If Bryan kicked three of the garden gnomes in the yard, then the flowers will be trampled soon too.
? Might Bryan make a mess of the yard? Y

Filler 9 a
If Carlos payed some of the bills that arrived this morning, then the fines must be payed TOMORROW morning.
? Does Carlos need to pay his bills? Y

Filler 10 a
If Carmen distributed many of the flyers before her lunch break, then she'll take the rest of the day off.
? Was Carmen designing flyers before lunch this morning? N

Filler 11 a
If Carlos hugged SOME of his younger brothers before bed today, then his sister will want a hug too.
? Does Carlos have more than one brother? Y

Filler 12 a
If Carmen bore most of the responsibility for the car accident, then she will probably pay for the damage.
? Is it certain that Carmen will pay for the damage to the car? N

Filler 13 a
If Daniel observed SEVERAL of the animals in their natural habitats, then the snakes were among the animals he observed.
? Did Daniel definitely observe bears? N

Filler 14 a
If DEVIN groomed five of the puppies in the animal shelter, then the other employees will care for the kittens.
? Is Devin the only employee at the animal shelter? N

Filler 15 a
If Edward hammered some of the nails in the wooden plank, then the hammer must not be needed anymore.
? Was the plank Edward worked on made of wood? Y

Filler 16 a
If Ella scored lots of the goals during the soccer game, then a few were scored by other players.
? Is Ella a basketball player? N

Filler 17 a
If Edward harvested MUCH of the wheat crop before the frost, then his family will have enough to eat.
? Is Edward a farmer? Y

Filler 18 a
If ELLA plowed half of the driveway next to her house, then the other half must be cleared later today.
? Is it ok if Ella only plows half the driveway? N

Filler 19 a
If Garrett discovered SOME of the new compounds in his lab, then the other researchers will be slightly jealous.
? Will the other researchers be a bit jealous of Garrett if he made some discoveries? Y

Filler 20 a
If Galya climbed some of the trees in the front yard, then the rest are too tricky to climb.
? Would Galya probably climb all of the trees if she could? Y

Filler 21 a
If Garrett cleaned most of the scrapes on his LEFT leg, then the ones on his right leg must not be so serious.
? Did Garrett scrape his right leg? Y

Filler 22 a
If Galya painted eight of her nails before going to dinner, then the other two will be done tonight.
? If Galya started painting her nails, will she finish? Y

Filler 23 a
If Finn buried some of the gems by the little brook, then his friends will find them before dinner.
? Will Finn's friends be unable to find the gems if they are by the brook? N

Filler 24 a
If Finola swallowed SOME of the pills that her doctor prescribed, then the ointment will be applied at night.
? Did Finola get a prescription from the doctor? Y

Filler 25 a
If Finn played MOST of the songs on the new album, then his friends must not like the others.
? If Finn does not play all the songs will it be because of his parents? N

Filler 26 a
If Finola purchased five of the APPLES in the big basket, then the PEARS must not have looked good.
? Is Finola deciding between apples and pears at the store? Y

Filler 27 a
If HECTOR ran part of the marathon that took place yesterday, then that is very impressive.
? Did Hector participate in a triathlon yesterday? N

Filler 28 a
If Holly invited ALL of her friends to the dinner party, then MANY of them will end up attending.
? Will some of the people Holly invited decide not to come to the party? Y

Filler 29 a
If Hector promised three of his cousins presents for their birthdays, then he'll have to give presents to them all.
? Is it ok for Hector to give presents to just a few cousins? N

Filler 30 a
If Holly returned SOME of the library books before the weekend, then the overdue fees will less than if she waits till Monday.
? Were Holly's books due before Monday? Y

Filler 31 a
If Ian saw most of his ex boyfriend's new Facebook photos, then the rest of the day will be rough.
? Is Ian totally over his ex boyfriend? N

Filler 32 a
If Isabel picked TEN of the tomatoes off her neighbor's the vine, then the neighbors must be very angry.
? Do Isabel's neighbors have a tomato plant? Y

Filler 33 a
If Ian donated all of his old pants earlier this year, then the rest of his pants must still fit.
? Would Ian have donated pants that still fit him? N

Filler 34 a
If Isabel collected SOME of the shells down by the seashore, then the shells must have been very pretty.
? Does Isabel prefer to collect pretty shells? Y

Filler 35 a
If Jackson watched some of the youtube videos of yelling goats, then he will probably get little homework done tonight.
? Will Jackson be just as productive if he goes on youtube as if he does not? N

Filler 36 a
If JACQUELINE won several of the tennis matches she played in, then she will advance to the next tournament.
? Does Jacqueline need to win all the matches to advance to the next tournament? N

Filler 37 a

If Jackson earned one of the awards the university gives out, then the REST went to other qualified students.
? Does the university give more than one award? Y

Filler 38 a
If Jacqueline dried SOME of her new pants in the dryer, then some of them will shrink.
? Might Jacqueline's pants shrink? Y

Filler 39 a
If Kareem shaved all of his hair off of his head, then he won't need his comb anymore.
? Will Kareem need his comb even if he shaves his head? N

Filler 40 a
If Katrina learned some of the dance moves in class yesterday, then the dance teacher must be very good at her job.
? Does Katrina go to dance class? Y

Filler 41 a
If Kareem landed SOME of the difficult jumps on his feet, then the other times he must have fallen.
? Was Bill the one who was jumping? N

Filler 42 a
If Katrina answered most of the questions on her homework exercises, then the REMAINING questions must be too hard.
? If Katrina did not answer all of the questions, is it because she is lazy? N

Filler 43 a
If Leandro attended few of the court mandated Alcoholics Anonymous meetings, then the judge will send him to jail.
? Has Leandro been ordered to attend AA meetings? Y

Filler 44 a
If Lucia painted SOME of the artwork for this weekend's show, then she will sell some of the paintings for a lot of money.
? Is Lucia a painter? Y

Filler 45 a
If Leandro filled some of the water glasses on the table, then the wine glasses must be filled before dinner.
? Is there only one type of glass on the table? N

Filler 46 a
If Lucia ordered SEVERAL appetizers for all the guests to share, then the others won't need to order more.
? Will more appetizers need to be ordered even if Lucia ordered several? N

Filler 47 a
If MARCUS believed most of the lies his brother told him, then his brother will tease him for many years.
? Did Marcus' brother lie to him? Y

Filler 48 a
If Mallory spent HALF of her paycheck on this month's rent, then the tips she earned will be very helpful.
? Does Mallory own her apartment? N

Filler 49 a
If Marcus hit some of the home runs during the game, then the other players also hit some homers.
? Is Marcus the only player capable of hitting homers? N

Filler 50 a
If Mallory wrote SOME of the thank you notes before lunch, then she will write in her journal after dinner.
? Is Mallory likely to write thank you notes both before and after lunch? Y

Filler 51 a
If Nikolai blamed four of his coworkers for the lackluster quarter, then the office climate will be very strained.
? Does Nikolai have coworkers? Y

Filler 52 a
If Neha threw SOME of the pitches during the softball game, then the batters all struck out.
? Is Neha a catcher? N

Filler 53 a
If Nikolai knocked some of the GLASSES off the coffee table, then the PLATES will probably still be intact.
? Did the plates and the glasses probably both get knocked off the table? N

Filler 54 a
If Neha pressed all of the flowers that she collected YESTERDAY, then the remaining flowers are ones she picked on Monday.
? Did Neha spend more than one day picking flowers? Y

Filler 55 a
If Omar plowed part of the street after the big snowstorm, then he will be able to drive his car to work.
? Did it snow recently where Omar lives? Y

Filler 56 a
If Olivia settled some of the debts she owed her creditors, then her house will probably not be foreclosed.
? Does Olivia owe money? Y

Filler 57 a
If Omar lent SOME of his pencils to a few classmates, then the rest have their own writing implements.
? Is Omar the teacher? N

Filler 58 a
If Olivia tore part of her sweater while climbing a tree, then her OTHER sweaters will have to suffice.
? Does Olivia only own one sweater? N

Filler 59 a
If Daniel pried THREE of the cans of peaches open earlier, then the pineapple cans must still be sealed shut.
? Does Daniel have more than one type of canned fruit? Y

Filler 60 a
If Devin measured some of the rooms in her new apartment, then the closets need to be measured SOON.
? Is Devin moving to a new apartment? Y

Filler 61 a
If Pedro mentioned some of the articles he read last week, then the books he read must not have been interesting.
? Will Pedro only mention uninteresting articles? N

Filler 62 a
If Polly shot TEN arrows at the target during archery practice, then she PROBABLY hit the bullseye five times.
? Will Polly hit the bullseye a majority of the time? N

Filler 63 a
If PEDRO shook SOME of the soda bottles his mom bought, then the people who open them will be surprised.
? Will the people opening the bottles expect them to have been shaken? N

Filler 64 a
If Polly blocked most of the other team's shots on goal, then the rest must have made it in.
? Is Polly a goalie? Y