GENERALIZED IMPLICATURES: DO UNINFORMATIVE ENVIRONMENTS ELIMINATE DEFAULT INTERPRETATIONS?

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ABSTRACT

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Recent experimental work has sought to determine whether there are two distinct categories of implicated meaning. Generalized implicatures arise largely independent of context, and particularized implicatures depend on the context in which they occur for their full interpretation to go through (Grice, 1975). Pragmatic models differ about whether there are independent mechanisms for each type of meaning. Some theories assume these two categories are generated by the same context-dependent mechanism (Carston, 2002; Sperber & Wilson, 1986). Other theories, in contrast, assume that generalized implicatures are default inferences that get computed automatically regardless of the context (Chierchia, 2004; Gazdar, 1979; Levinson, 2000).

The experiments reported in this dissertation were designed to test these competing predictions by examining the processing of contrastive pre-nominal modifiers. Sedivy, Tanenhaus, Chambers, & Carlson (1999) showed that upon hearing an instruction, such as *Pick up the tall…*, the probability of fixating a tall glass will begin to increase, even before the onset of the noun when the visual display contains a contrasting object (i.e. a short glass). This result shows that the comprehension system has certain expectations with regard to quantity of information. In this case, people rely on their knowledge that modifiers are often used to distinguish contrasting objects, and Sedivy et

al.'s data indicate that people can rapidly integrate this linguistic knowledge with the available visual information to make an inference about what the target will be.

The results from the first two experiments showed that this inference can be modulated by the extent to which modifiers are used to distinguish contrasting objects over the course of the experiment. When participants were in an informative task environment with respect to modification, they showed early looks to the target. In contrast, subjects who heard a high number of uninformative modifiers failed to show anticipatory looks to the target. These results cast doubt on the default view, which assumes that the contrastive interpretation should be available immediately in all contexts.

In the third experiment, I tested another type of contextual manipulation. In most cases, an indefinite expression (e.g. *a glass*) is used to introduce an object into the discourse, and afterwards the entity will be referred to with a definite expression (e.g. *the glass*). In the third experiment, I introduced all of the objects linguistically on each trial with an indefinite expression to determine if this changes the pattern of results that was obtained in the previous two experiments. The key issue is whether visual co-presence provides the adequate conditions for the use of a definite description. If it does not, then adding a short linguistic introduction should facilitate processing when contrasting objects are present, and it should impair processing in the absence of a contrasting object. The results showed little change with the linguistic introduction, suggesting that visual co-presence is sufficient to support a definite referring expression.

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INTRODUCTION

Any adequate theory of language use must be able to account for both sentence meaning and speaker meaning. Sentence meaning, sometimes called literal meaning, is determined by the syntax and the semantics of the grammar, and refers to the literal meaning of words and phrases. Speaker meaning often conveys more information than sentence meaning because speakers implicate additional information in choosing the words and phrases they do in particular situations. Pragmatics is the field of study that focuses on what people mean with utterances, rather than the actual meaning of those utterances. This means that pragmatics necessarily involves the relationship between linguistic forms and their users, including background knowledge, assumptions about each other, and goals in a particular conversation.

The philosopher Paul Grice was the first to systematically study how listeners generate precise and detailed inferences beyond what is coded in sentence meaning. Grice divided this additional meaning into two broad categories called conventional implicatures and conversational implicatures. Conventional implicatures include presuppositions and entailments. Presuppositions are defined as background assumptions, which must be true. For example, the statement *my wife is pregnant* presupposes that I have a wife. Entailments are defined as something that logically follows from the content asserted in an utterance. For example, a sentence such as *Lincoln was assassinated,* entails that Lincoln is dead. Conversational implicatures, in contrast, are based on a listener's assumption that a speaker is being rational and cooperative. One of the defining characteristics of conversational implicatures is that they are cancellable without being contradictory. For example, an utterance such as *Frank has four children,* typically implicates that Frank has **only** four children. However, it is acceptable to cancel or to deny the implied content, as in *Frank has four children, in fact he has five.*

Grice made one further distinction within conversational implicatures. Generalized (conversational) implicatures do not dependent on special features of the context for their interpretation to go through. An example of this type of implicature is *John thinks the meeting is today.* In this utterance, *thinks* can mean two things. The first is the literal meaning, which is that John actually believes that the meeting is today. The second interpretation is that John does not know for sure when the meeting is, and in this case, *thinks* implicates uncertainty. Particularized (conversational) implicatures depend on the context in which they occur. This contextual dependence can be captured in a recent dialogue that occurred along Grand River Avenue.

> Erik: How did it go?
> Paul: Great, I finished right on time and I had questions for the entire discussion period.

In these kinds of isolated contexts, the conversational participants imply and infer some things without providing any clear linguistic evidence to the meaning of what was communicated. If you heard this conversation without the critical background knowledge, then you would have no idea that the conversation was about a talk given at the Cognitive Science Conference.

These different types of meaning are represented in a hierarchical structure in Figure 1. The basic idea is that the total meaning of an utterance is a composite of different sources of information. At one end you have syntax and semantics which contributes to the literal meaning of an utterance. At the other end you have implicated content which is based on context, and is unique to particular individuals at particular points in time. Within the implicated meaning, conventional implicatures and generalized implicatures are stable across contexts, and as a result they are normally inferred. Particularized implicatures depend on the context, and critically, they depend on a listener's assumption that a speaker will behave in a certain way.

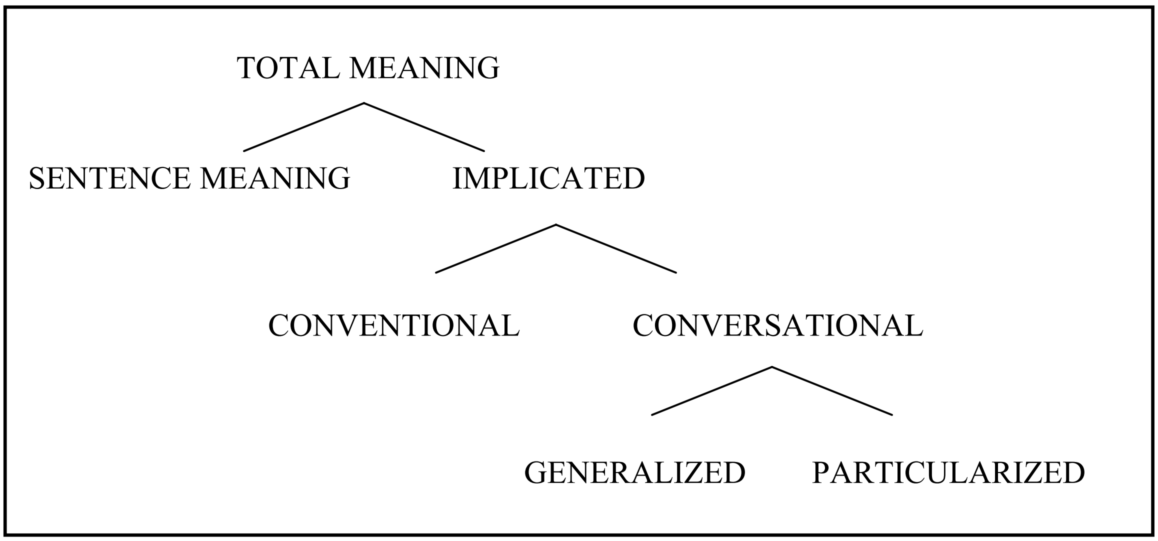

Figure 1. Diagram showing the different types of implicated meaning proposed by Grice (1989).

1.0 Gricean and Neo-Gricean Theories of Implicature

As just defined, implicature is the part of communication that is implied or meant, rather than what is actually said. The pragmatic approach has been largely guided by the idea that conversational participants act in a rational and cooperative manner, so that communication can proceed as efficiently as possible. Grice defined the Cooperative Principle in the following way, "Make your conversational contribution such as is required, at the stage at which it occurs, and by the accepted purpose or direction of the talk exchange." (Grice, 1967, pp. 45). In addition to the cooperative principle, Grice also formulated a set of maxims which are assumed to govern the types of implicatures that speakers make (see Table 1). These maxims are unstated assumptions that speakers and listeners should follow when interacting in conversation. This overall framework provides a way to classify different types of implicature, as well as to make predictions about what types of inferences a listener should generate.[1] Grice's theory however, did not address how these implicatures are computed in online language processing.

Table 1. Maxims of conversation which are assumed to govern speakers choices, so that conversation can proceed in a rational and cooperative manner.

(1) Maxim of Quality
- a. Do not say what you believe to be false
- b. Do not say that for which you lack evidence

(2) Maxim of Quantity
- **a. make your contribution as informative as is required**
- **b. do not make your contribution more informative than is required**

(3) Maxim of Relation
(4) Maxim of Manner
- a. avoid obscurity
- b. avoid ambiguity
- c. be brief (avoid prolixity)
- d. be orderly

1.1 Cognitive processing issues

There has been quite a bit of debate as to whether pragmatic theories should bear on cognitive issues concerning production and comprehension. Some theories, such as the one proposed by Horn (1984; 2004), assume that the study of pragmatics should

[1] I will use the term "inference" interchangeably with "implicature". However, in general, speakers communicate extra meaning with implicature, and listeners recognize meaning with inference. Inference refers to a listener's ability to interpret an utterance to mean more than the content that was asserted in the utterance.

exclusively focus on how and what a speaker says given the idea that they want to communicate. No consideration is given to cognitive implementation or to comprehension. Sperber and Wilson (2002), in contrast, argued that pragmatics must fit into the larger domain that seeks to understand human communication within the limitations of the cognitive processes that support it. To this goal, Sperber and Wilson proposed to eliminate the principles and maxims outlined by Grice, and attempted to replace them with a single cognitively-oriented processing principle based on relevance. According to Relevance theory, both speakers and hearers abide by the assumption that each will choose utterances and interpretations that convey the maximal amount of information with the least cognitive processing effort (Zipf, 1949).

A third position was proposed by Levinson (2000). His views fall somewhere between Horn's theory and Relevance theory. Levinson's theory maintains much of the basic machinery (i.e. the cooperative principle & maxims of conversation) from Grice, while at the same time attempting to account for real time processing. Levinson maintains a cooperative perspective in the form of a tacit agreement between interlocutors that the maxims of conversation are operative unless there is explicit evidence otherwise. Levinson's theory is probably the most complete Neo-Gricean proposal for how generalized implicatures are computed (see also Bach, 1995).

1.2 Models of comprehension

One of the key theoretical questions in pragmatics is whether generalized implicatures are computed in a separate stage from particularized implicatures. There are two main classes of processing models. One class assumes that generalized implicatures are computed automatically and by default, similar to conventional meaning. This view further predicts that generalized implicatures are computed prior to particularized implicatures. This class of models can be further sub-divided according to whether they predict an encapsulated system specifically for generalized inferences (Levinson, 2000, panel B of Figure 2), or whether they predict that generalized inferences are computed from the grammar (Chierchia, 2004, panel A of Figure 2). The second class of models assumes that generalized implicatures are context dependent. The context-dependent models predict that both generalized and particularized implicatures are derived from a single pragmatic processing system, which operates on the output from the grammar (Carston, 1995, 2002; Sperber & Wilson, 1986).

These models are presented in simplified schematic diagrams in Figure 2. In this figure, the processing stages are represented in a left-to-right orientation beginning with the language input and ending with speaker meaning. All of the models share at least one feature in common: particularized implicatures are generated by a system that is influenced by the conversational context. Currently, the key debate concerns how and when generalized inferences arise. In Figure 2, panels A and B show the two versions of the default view (Chierchia, 2004 & Levinson, 2000, respectively). The first places generalized implicatures with the semantics of the grammar. Levinson, in contrast, postulates a separate processing stage, specifically for generalized inferences. In both of these cases, there may be a situation in which a generalized implicature is computed, and the later contextual information may require it to be cancelled. Panel C shows the context-dependent view. Here the main assumption is that all pragmatic inference takes place in a single context-dependent processing stage. In addition, contextual considerations can influence whether a generalized implicature gets computed or not. The key issue that I am interested in, and the one that separates models A and B from model C is whether the system generates generalized inferences by default or whether generalized inferences can be influenced by context.

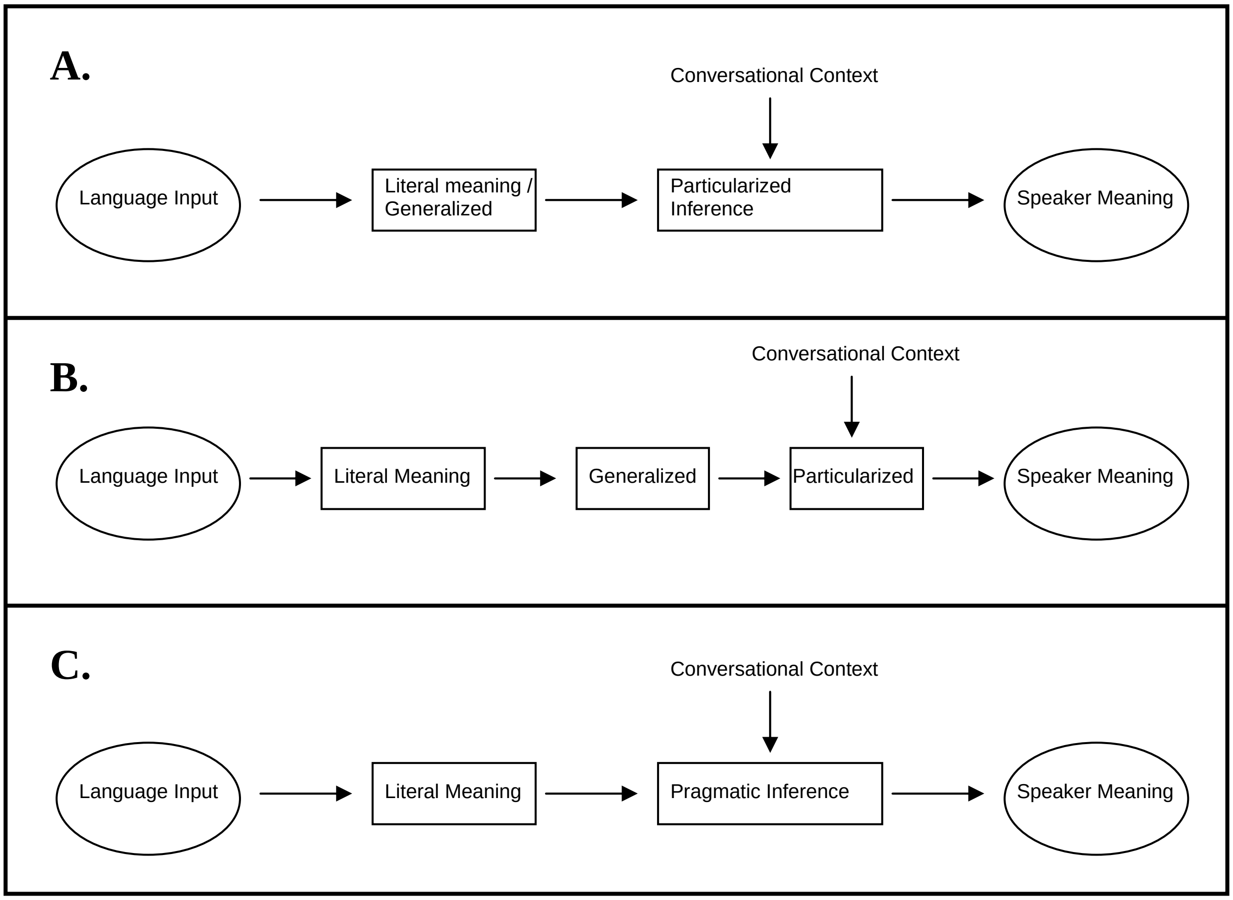

Figure 2. Schematic diagrams showing the three main types of models with respect to where they locate the computation of generalized implicatures in comprehension.

Investigations of these architectural assumptions have used a variety of test cases and experimental paradigms. The most extensively studied is single sentence truth-value judgments probing the interpretation of a scalar term like *some*. More recently, investigations have included visual world studies, which have provided online measures of the speed at which different interpretations are made. The results from these studies have generally supported the context-dependent view. In the current series of experiments, I address the theoretical debate concerning the automaticity of generalized inferences by testing whether a contextual manipulation based on informativeness can influence the processing of pre-nominal adjective modifiers. If the default view is correct, then participants should immediately interpret a size modifier contrastively regardless of the context. On the other hand, if context influences initial processing, then the context-dependent view would be supported. However, I will first review the relevant literature that has looked at these issues with scalar inferences.

2.0 Scalar implicatures

By far the most empirical work looking at the time course of generalized implicatures has been done on scalar inferences (Bezuidenhout, & Morris, 2004; Bott & Noveck, 2004; Breheny, Katsos, & Williams, 2006; Noveck & Posada, 2003). This type of inference is commonly communicated on the basis of a scale of values, and as a result they are known as scalar implicatures. The most common scale deals with quantity, and examples include: *all, many, some,* and *few*. The most extensively studied example is *some.* The two interpretations of *some* are "some and possibly all" and "some but not all". The former is called the logical or literal interpretation and the latter is the pragmatic interpretation. The implicature arises when a speaker selects a less informative term when he or she is in a position to use the stronger term, which follows from the first Quantity Maxim to provide as much information as you have evidence to support. Consider the following dialogue,

A: Did your PSY 209 students pass?
B: Some of them.

Person A in this case will likely infer that not all of the students passed the course because if all passed then person B should have said so. Bott and Noveck investigated the comprehension of this type of scalar inference using true-false judgments. In example (1), the logical meaning of the sentence is true, and the pragmatic meaning is false. Bott and Noveck found that adult subjects rated the sentence "false" 59% of the time. However, an examination of reaction times showed that subjects were substantially slower when they responded "false" than when they responded "true" (3360 ms vs. 2617 ms).[2] In addition, when subjects were placed under time pressure, they were even more likely to respond "true". On the basis of these data, Bott and Noveck argued that generalized implicatures are not automatic, rather their data suggest that these interpretations take substantially more time and processing effort to generate. Similar results were obtained by Noveck and Posada (2003). Their results showed that "true" responses were approximately twice as fast as "false" responses, indicating that the pragmatic interpretation is an effortful, and rather late arriving interpretation, which is contrary to the default view.

(1) Some elephants are mammals.

Recall that the default view and the context-dependent view also make different predictions about when a generalized implicature is computed. The context-dependent position assumes that the mere presence of a scalar won't necessarily trigger the pragmatic interpretation. Rather the pragmatic interpretation will be triggered only when the context requires it. The pragmatic interpretation therefore, should come later and take some extra processing effort compared to the logical meaning. The default view, in contrast, assumes that the scalar inference will be triggered immediately upon

[2] Control conditions for this experiment included five test sentences that were either patently true or patently false. These sentences were answered correctly 92% of the time and the average response time was 2605 ms.

encountering a scalar term, such as *some.* The competing predictions arise when the context requires the logical interpretation. In this case, the default view predicts that it should take longer to arrive at the intended interpretation because the pragmatic interpretation will be initially pursued, and then it will have to be canceled in favor of the logical interpretation. The context-dependent view assumes the logical interpretation will come first, and that the pragmatic interpretation will only be adopted when the context warrants it.

These predictions were tested in an eye movement study with short discourses that required the logical interpretation of a scalar inference (Bezuidenhout, & Morris 2004). In example (2), the scalar inference is explicitly cancelled by the first clause of the second sentence. If the default interpretation is *some but not all*, then there should be some processing difficulty when the cancellation sentence is processed. On the other hand, if the pragmatic interpretation is made only when the context warrants it, then there should be little evidence of revision during the second sentence. These competing predictions were tested by examining reading times for sentences like example (2) compared to similar sentences that began *Many books…* or *The books….* The results showed a slight slow down in first pass reading times during *all* with the sentence that began *Some books….* However, the *some* condition was the fastest of the three tested during *them did*, which does not indicate processing difficulty, as predicted by the default view. Furthermore, there were no significant differences between any of the three conditions in regressions or second pass reading times.

(2) Some books had colored pictures. In fact all of them did, and that’s why the teacher liked them.

The processing of scalar inferences has also been looked at in one additional paradigm. Huang and Snedeker (in press) used a visual world task where subjects heard instructions such as *point to the girl that has some of the soc…*, the displays in this experiment were designed such that the final noun was ambiguous between two objects (e.g. socks & soccer balls). In the visual display, one boy had no objects, one girl had three soccer balls, one girl had two socks, and one boy had two socks. The results showed that the probability of fixating the target (i.e. the girl with half of the socks) began to increase before the point of disambiguation, which suggests that subjects were able to anticipate the target based on the pragmatic interpretation. However, there were three comparison conditions, and each was disambiguated at the quantifier.[3] Compared to each of these three controls, the *some* condition took longer to fixate the target. This delay also casts doubt on an automaticity assumption for the generalized interpretation (see also Grodner, Klein, Carbary, & Tanenhaus, March, 2008).

Summing over the total work that has been done on scalar inferences indicates that the pragmatic interpretation is adopted more often than the logical interpretation in offline judgments, but it takes substantially longer to arrive at the pragmatic interpretation. The online measures of processing also showed a delay for the pragmatic interpretation. These findings suggest that drawing generalized implicatures is not an automatic process; therefore, these data favor model C over models A and B in Figure 2.

2.1 Contrastive inferences

A second type of generalized implicature is the contrastive inference originally shown by Sedivy and colleagues. Reference is a property of language, in which specific

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[3] The control conditions for the example described above were 1) *point to the girl that has all of the soc..*, 2) *point to the boy that has two of the soc..*, 3) *point to the girl that has three of the soc…*. In all three conditions the target can be identified at the quantifier.

objects in the environment can be identified using modified noun phrases. So for an expression such as *the man,* the definite article *the* presupposes the existence of a single uniquely identifiable man in the context (Epstein, 1998; Heim, 1982). However, if there is more than one man in the context, then any number of modifiers could be used to select one particular individual from the set, such as *the smart man,* or *the smart man from Texas,* or *the smart man from Texas in the White House*.[4] These modifiers and nouns can be viewed as predicates that denote a set of objects. More simply, a referential expression involving one adjective and one noun (e.g. *red triangle*) defines an intersection of sets (Kamp & Partee, 1995). More specifically, a word like *triangle* can mean the set of triangles, so [triangle] = {*x* : x is a triangle}, while the word *red* can mean the set of red things [red] = {*x* : x is a red}. The phrase *red triangle* is then interpreted as the intersection of the set of red things with the set of triangles: {*x* : x is a triangle} ∩ {*x* : x is a red} = {*x* : x is red ^ x is a triangle}.

As discussed above, a definite noun phrase must have a link with the context, such that an entity fitting the description must be in the context for a noun phrase to successfully refer. Size adjectives are one example of this direct link between a linguistic representation and context. This is because an adjective, such as *tall* does not have a fixed value, rather it can only be interpreted in comparison to some other object (Bache, 1978; Bierwisch, 1987; Ferris, 1993; Kamp, 1975; Richards, 1977; Seigel, 1980). For example, *tall* has a quite different meaning when used to describe a seven year old (~51 inches) compared to when it is used to describe a basketball player (~82 inches). This difference in absolute height shows that size does not have a fixed value.

[4] I would like to thank the committee for pointing out that this example does not likely refer to anyone in the real world, and the issue of possible worlds is too complicated to consider here. Interested readers should consult Prince (1978).

Sedivy et al. (1999) looked at the role of multiple referents on the comprehension of pre-nominal size adjectives. They found that if a participant hears an instruction such as *pick up the tall…* the probability of fixating *the tall glass* will start to increase even before the onset of the word *glass,* suggesting that subjects can anticipate a referent on the basis of partial input (see Altmann & Kamide, 1999 for a similar anticipatory effect). Crucially, this result is only obtained when the display contains a contrasting object, such as *a short glass*. These results are striking because participants are able to anticipate a referent on the basis of the modifier alone, suggesting that listeners are indeed sensitive to the presence of contrasting referents, and as a result have an **expectation** for modification to distinguish them.[5]

Later work by Sedivy and colleagues looked at whether the same type of effect was evident with color modifiers. They found that when a participant hears an instruction such as *move the yellow...,* there were no early looks to the target based on the presence of a contrasting object, suggesting that the contrastive inference on the basis of partial input does not hold for modification in general. Therefore, Sedivy initially argued that the contrastive inference is due to a lexical property of size adjectives. More specifically, she argued that size adjectives are special, because they contain a variable which is determined by the context.

However, there were two additional pieces of evidence that caused Sedivy to change her conclusions. The first came from a study that examined material adjectives

[5] This anticipation of the target based on presence or absence of a visual contrast is referred to as a "contrastive inference". There are two reasons to assume that this contrastive inference is type of generalized implicature. The first is that the inference is cancelable, e.g. *Give me the tall glass because it's the only one there is* (Grodner & Sedivy, in press). The second is the immediacy of the result obtained by Sedivy et al. (1999), which suggests that the contrastive interpretation is the default for size modifiers. This argument further supported by production frequencies (see footnote 7 on page 26), which showed size modifiers were rarely produced when they were not needed.

such as *plastic* or *wooden* (Sedivy, 2006). The rationale for examining this class of adjectives was that material, like color, is an inherent property of an object. The results however, showed that material adjectives pattern like size adjectives, indicating that the early looks with a size modifier are not necessarily the result of a lexically-based variable. The second piece of evidence came from an experiment that included instructions such as *Pick up the yellow banana,* and the visual context contained both a yellow banana and a purple banana (Sedivy, 2003). With this type of contrast, Sedivy showed that color could be interpreted contrastively. On the basis of these data, she argued that the differential color effect depends on the object being modified. She ultimately concluded that the immediate contrastive interpretation is due to a pragmatic quantity-based inference.

In summary, we can assume that a listener's expectations about quantity can be driven by certain types of adjectives, and with certain types of visual contrasts. If a person hears an expression such as *point to the tall…,* then two interpretations are possible. The contrastive interpretation is that the modifier must be necessary to identify the target. The non-contrastive interpretation is when the modifier *tall* is not necessary, but describes a property of the target nonetheless. (This distinction has also referred to as restrictive and non-restrictive readings, respectively.) If Levinson's theory of generalized implicature is correct, then the contrastive interpretation should be the default. If however, initial processing can be modulated by features of the context, then this would cast doubt on the two-stage pragmatic architecture.

3.0 Summary

The current work uses cognitive processing facts to differentiate the different views on if and when generalized inferences are computed. Relevance theory assumes that both generalized and particularized implicatures are generated by the same mechanism, and both are subject to contextual influence. The default view assumes that generalized implicatures are computed automatically in a separate stage that is not affected by context.

OVERVIEW OF EXPERIMENTS

The current experiments investigate whether contrastive inferences are based on default interpretations, as proposed by Levinson, or whether they are due to a single context-dependent processing mechanism, as assumed by Relevance theory. The primary question of interest is whether the comprehension system always makes a contrastive inference when processing a modified noun phrase, or whether these effects are dependent on the context in which they occur.

There is one report in the literature showing the suspension of contrastive inferences with pre-nominal size and material modifiers. Grodner and Sedivy (in press) designed an experiment in which participants were told that they were going to execute a series of instructions that were recorded from a patient with a neurological disorder. Deficits were reported to include language and social problems. Participants were told that the purpose of the experiment was to determine how well speakers were able to convey information by examining participant's actions in response to spoken instructions.

In the experiment, the pre-recorded instructions from the "neurological patient" contained several instances in which objects or locations were mislabeled, as well a very high percentage of over-descriptions (> 80%).[6] This was referred to as the unreliable speaker condition. A second group of participants was assigned to the reliable speaker condition, which contained no mislabeled objects, and very few over-described utterances (< 8%). The results showed that participants in the reliable speaker condition benefitted from the presence of a contrast, whereas participants in the unreliable speaker condition did not. On the basis of these data, Grodner and Sedivy argued that contrastive inferences are likely due to pragmatic origins, rather than a lexical effect associated with specific classes of modifiers, which is consistent with Sedivy's other work (Sedivy, 2007).

This study leaves several key issues unresolved. First, it is possible that the suspension of contrastive inferences was due to the overt cue indicating a deficient or uncooperative speaker. The second issue was that primary data analysis occurred in a 500 ms time window beginning 200 ms past the offset of the adjective. The problem is that during this time window the utterance is no longer ambiguous, and as a result, it is not clear whether these data reveal anything about inferential processing. Third, the results were not connected with the architectural debates concerning the processing stages of generalized implicatures.

To get around these problems and to definitely test whether contrastive inferences are generated by default or open to contextual influence, I conducted three experiments. The first investigated the processing of the size and color modifiers to establish the sensitivity of the task to the contrastive inference. In the second experiment, I manipulated the informativity of modifiers across blocks of trials in a within subjects experiment. If contrastive inferences are suspended in an uninformative environment,

[6] The current paper the focuses on the use of pre-nominal modifiers in referential communication. I use the term under-description to refer to expressions that do not have enough information to allow a referent to be identified, and over-description to refer to expressions that have unnecessary or uninformative modifiers.

then this would cast doubt on the two-stage architecture proposed by Levinson (2000). The purpose of the final experiment was to investigate whether there was any change in processing if the objects were introduced on each trial with a short linguistic context. If visual co-presence does not support the use of the definite determiner, then I expect an added benefit compared to the experiments in which the objects were not introduced linguistically.

EXPERIMENT 1

The purpose of the first experiment was to determine the extent to which contrastive inferences are observed in the modified visual search task developed by Engelhardt, Xiang, and Ferreira (2008). In this task, participants are instructed to point to a target on the computer screen, as quickly as possible, while their eye movements are monitored. To determine the sensitivity of this task to the contrastive inference originally reported by Sedivy et al. (1999), two groups were run, each testing a different type of pre-nominal modifier (see Figure 3 & Table 2). The purpose of testing each modifier separately was to keep the number of over-descriptions as low as possible over the course of the experiment. Note that the experimental design requires one-half of the critical trials to be an over-description. I also wanted to ensure that there was no effect of over-described color trials on the processing of size modifiers and vice versa. Therefore, the ratio of over-descriptions to non-overdescriptions was kept as low as the experimental design could allow.

Recall that Sedivy et al. reported that subjects were faster to identify a target when hearing an ambiguous size modifier when the visual display contained a contrasting object. The same effect was not observed with an ambiguous color modifier. The key finding was that subjects showed evidence of anticipating the target at a point when the utterance was still ambiguous. This finding is quite remarkable considering the steps that are necessary for this type of inference to go through. First, the listener must know that the speaker intends to pick out one object from the display.[7] Second, if the speaker is obeying the Maxim of Quantity, then he or she should not include an unnecessary modifier.[8] Third, if the speaker included a modifier, then it must be to distinguish multiple entities of the same type. Therefore, the target has to be the contrasting object that matches the modifier. It is not entirely clear how the comprehension system is able to go through these steps to achieve a contrastive interpretation in the span of the modifier word. Grodner and Sedivy speculated that the processing system might be able to statistically link the steps to short-circuit the seemingly cumbersome reasoning process.

For this experiment, I predict that participants will be faster to fixate the target when hearing an ambiguous size modifier when the display contains a contrasting object, compared to when it does not. The basis for this prediction is twofold. The first is that size is variable, that is size is only determined in comparison to some other object. The second is production frequency, which according to Sedivy's data, suggests that size modifiers are only used when contrasting objects are present. In the color group, there should be no difference in the speed of identifying the target based on the presence/absence of a contrasting object. Again, this prediction is based on the finding by

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[7] This is explicitly given information in the experimental instructions, but is also signaled on every trial with the use of the definite article *the*. The purpose of the third experiment was to investigate the felicity conditions on use of the definite determiner in this particular experimental task. And I elaborate on the relevant issues of the definite determiner there.

[8] Sedivy (March, 1999) collected some production data, and the results showed that color modifiers were produced on ~50% trials where they were not needed (see also Deutsch & Pechmann, 1982; Engelhardt, Bailey, & Ferreira, 2006; Pechmann, 1989). Size modifiers were rarely (~2%) provided when no contrast was present. On the basis of these data Sedivy argued that comprehension preferences seem to follow production tendencies.

Sedivy and others that color modifiers are very often used in the absence of contextual contrasts.

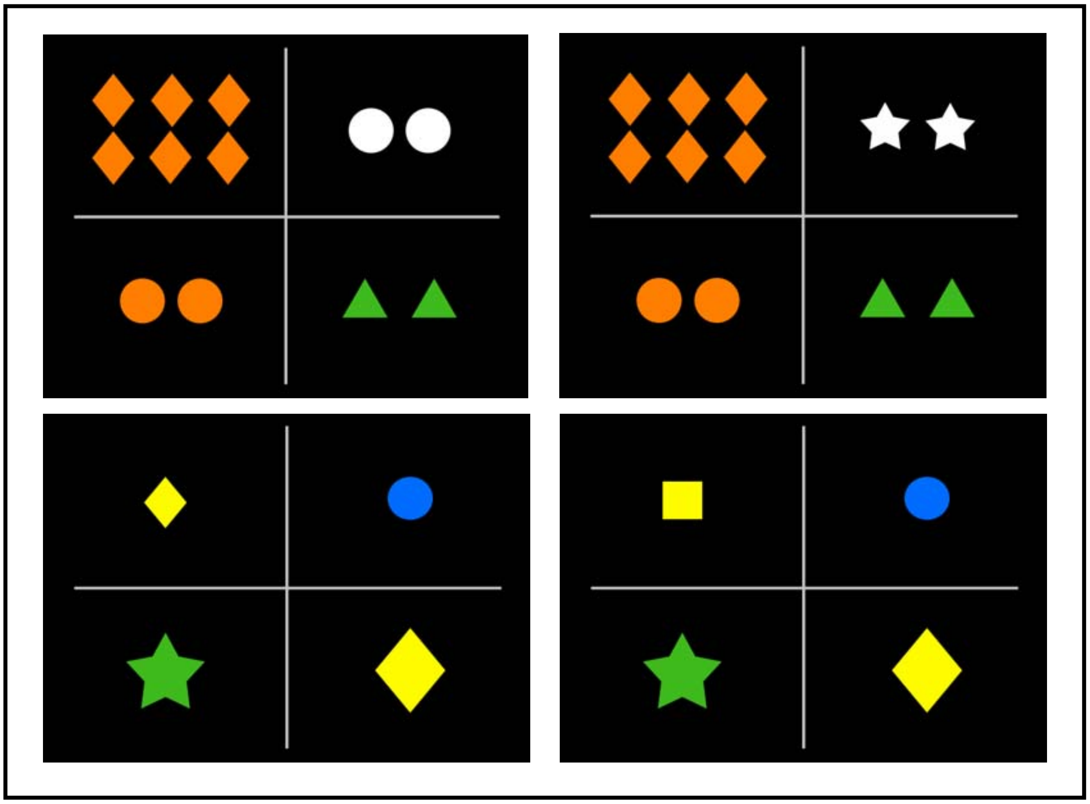

Figure 3. Example stimuli for Experiment 1. The top pair shows displays for the color condition. The bottom pair shows displays for the size condition. The left panels show the contrast displays and the right panels show the no contrast displays.

Table 2. Example instructions for Figure 3.

Instruction type	Modifier type
(1) Point to the orange circles.	color
(2) Point to the big diamond.	size

METHOD

Participants. Sixty-four undergraduate psychology students from Michigan State University participated for course credit. All were native speakers of English, and had normal or corrected-to-normal vision.

Stimuli. Utterances were recorded by a female native speaker of English who was naïve of the design of the experiment. She was instructed to produce the utterances in an even tone, and if anything to place stress on the noun rather than the adjective. Utterances were recorded using Adobe audition software, and converted to .wav format (see Table 3 for durations of modifiers & nouns for critical trials). Two lists were created so that for each experimental utterance, two visual displays were possible (see examples in Table 2 & Figure 3); each list contained 18 critical utterances and 54 filler utterances. Each critical utterance appeared once in each list, and visual displays were counterbalanced so that subjects received an equal number of trials (i.e. nine) in each of the two conditions. Note that for the size contrasts there were only two sizes of each shape. This means that big vs. small and large vs. little were essentially fixed over the course of the experiment. In order to give participants some familiarity with these contrasts, two practice trials required pointing to a size contrasting object.

Table 3. Mean duration of adjectives and nouns in critical instructions in milliseconds. Standard Deviations are in parentheses.

	Size	Color
Adjective	331.7 (63.6)	514.0 (81.1)
Noun	845.4 (116.5)	1052.0 (140.7)

The visual displays were designed such that the target, competitor, and distractor objects had an equal probability of appearing in each of the four quadrants of the display. Each of the fifty-four filler trials contained one modifier, and each uniquely identified a single quadrant of the display.[9] For the size group, 36 filler instructions contained a color modifier, and 18 contained a size modifier. For the color group, 36 fillers contained a number modifier and 18 contained a color modifier. In both experiments, 36 fillers were unambiguous at the modifier and 18 were ambiguous. To reduce within experiment correlation between the presence of contrasting objects and pre-nominal modification, two things were done. The first was that 16 fillers contained a contrasting pair of objects and neither was the target. The second was that six filler trials contained a modified noun phrase that referred to a competitor object in a display like those shown in Figures 5 and 7. The visual array of objects subtended 22^{o} of visual angle horizontally, and 17^{o} of visual angle vertically, for a viewing distance of 82 cm.

Apparatus. Eye movements were recorded using an SR research Eyelink II eye tracker (SR Research Inc.) sampling at 500 Hz. Viewing was binocular, but only the position of the right eye was tracked. Stimulus presentation was programmed using SR research Experiment Builder software. The eye tracker and a 19” CRT display monitor were interfaced with a 3-GHz Pentium 4 PC, which controlled the experiment and logged the position of the eye throughout the experiment.

Design and Procedure. The design was a 2 x 2 (display type x modifier type). Display type was within subject, and was contrast present or contrast absent. Modifier type was either size or color, and this variable was manipulated between subjects. Prior to

[9] In all three of the following experiments, there are no instructions that fail to refer to an object in the display. There are also no displays in which an instruction refers to more than one object. These are the two ways in which reference can fail.

the experiment, participants were shown all of the objects and colors that would be used in the experiment (see Table 4). The eye tracker was then fitted on the participant and calibrated. During calibration and throughout the experiment the head was stabilized with the use of a chinrest.

Table 4. Modifiers and nouns used in critical trials in Experiments 1, 2, and 3. Word frequencies are given in parentheses following each word (Brown corpus).

Size Modifiers	Color Modifiers	Head Nouns
big(360)	blue(143)	circle(60)
large(361)	gray(80)	diamond(na)
small(542)	green(116)	heart(173)
little(831)	orange(23)	moon(60)
	pink(48)	square(143)
	purple(na)	star(25)
	red(197)	triangle(na)
	white(365)	
	yellow(55)	

**na* = not available in Brown corpus list of 5000 most frequent words.

After calibration, three practice trials were completed in order to familiarize the participant with the procedure. The participants' task was simply to point to a particular target on a computer screen as quickly as possible. Each trial began with a drift-correction fixation point presented at the center of the computer screen. Participants were instructed to look at the dot and the experimenter initiated the trial. The visual display appeared 1500 ms before the spoken instruction began and it remained on the screen for approximately 1000 ms after the instruction was over (see Figure 4). The visual display was then removed and the drift correction dot reappeared. The order of trials was randomly determined for each subject. Participants performed the task while sitting down and the computer monitor was located approximately 82 cm in front of them. Participants were tested individually, and the entire session lasted approximately 20 minutes.

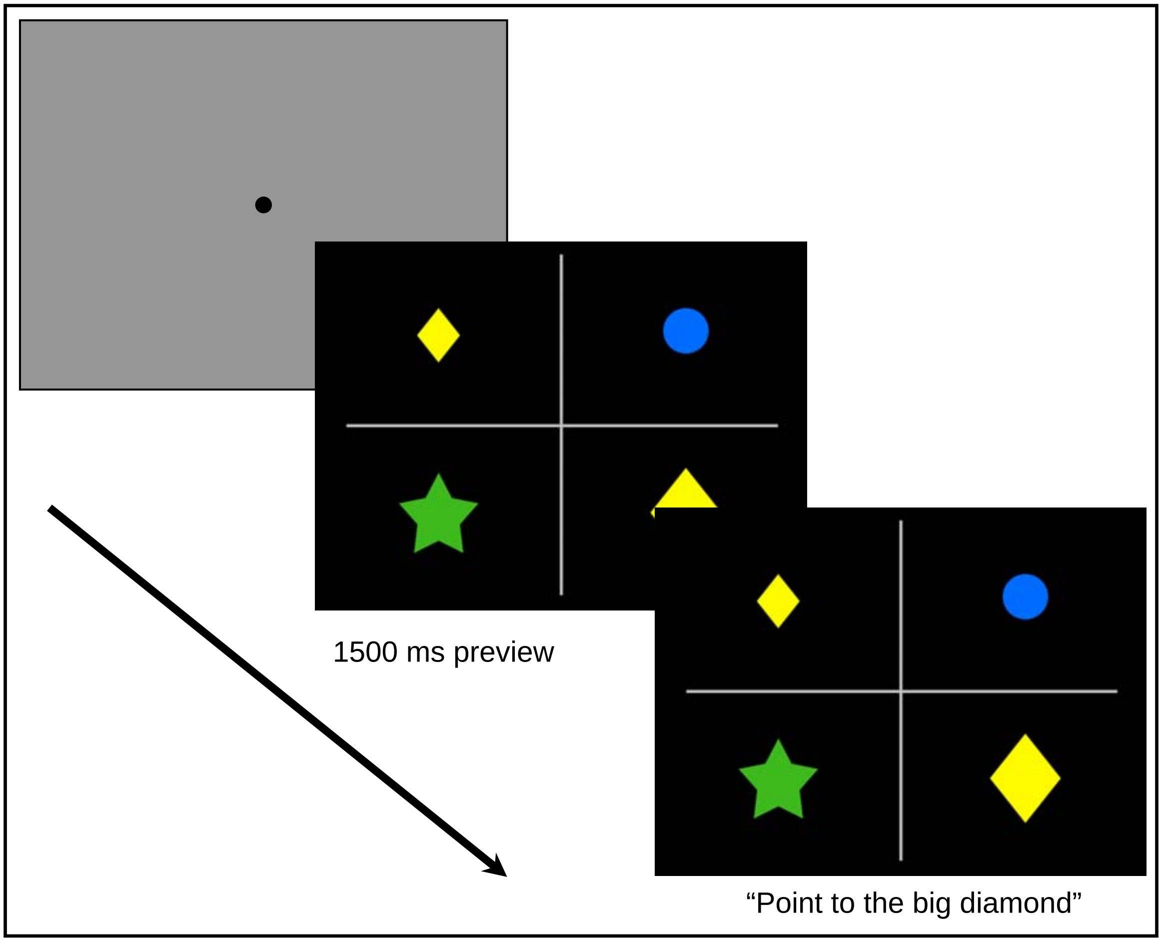

Figure 4. Trial sequence for Experiments 1 and 2.

The dependent measure was the proportion of trials with a fixation to each object in the display. The probability of fixating an object was calculated by determining the number of trials that contained a fixation in one of the four quadrants of the display during the modifier.[10] Note that the modifier time window is theoretically the most important because this is the point in which the instruction is still ambiguous. This is also

[10] The means for the noun time window are reported in Appendix A.

the point in time that Sedivy et al. reported an increase in the probability of fixating the target when the visual display contained a contrast. The number of trials with a fixation was divided by the total number of trials per condition (i.e. nine), so that the dependent measure was the proportion of trials with a fixation to a region during the modifier.

This measure however, excludes fixations that began before the onset of the modifier. This is because I am most interested in linguistically-mediated changes in fixation location. Any fixations to the target before the modifier word cannot be due to contrastive inference, so these fixations were excluded from the analysis. Subjects were excluded only if they responded extremely slowly or otherwise adopted an unusual response strategy. Slow responders were identified by examining the proportion of trials with a fixation during the noun. Any subject who had proportions at or near zero were excluded and replaced, so that an equal number of participants completed each list. This exclusion resulted in the replacement of 8 participants, in total, for all three experiments.

The modifier time window was time locked to the onset of the modifier and the noun, and the critical window was shifted forward 200 ms to account for the time necessary to plan a saccade. Word-time windows were identified by aligning utterances on a word-by-word and trial-by-trial basis (Altmann & Kamide, 2004). Analyses were conducted with both participants ($F1$) and items ($F2$) as random effects.

RESULTS and DISCUSSION

Recall that at the modifier position the instruction is temporarily ambiguous because there are two regions of the display that are compatible with the modifier. One is the target, and the other is referred to as the competitor (see Figure 5). For all of the following analyses, I present the results using two different measures. The first is the proportion of trials with a fixation to the target. The second is a target-advantage difference score, which was computed by subtracting the proportion of trials with a fixation to the competitor from the proportion of trials with a fixation to the target. This difference score provides a measure of the relative proportion of fixations to the objects in the display that should attract attention upon processing the modifier word. Positive values in this case represent a greater number of fixations to the target, and this provides an index of the extent to which the participants selectively attend to the target over the competitor object. Example stimuli and the means showing the proportion of trials with a fixation are shown in Figures 5 – 8.

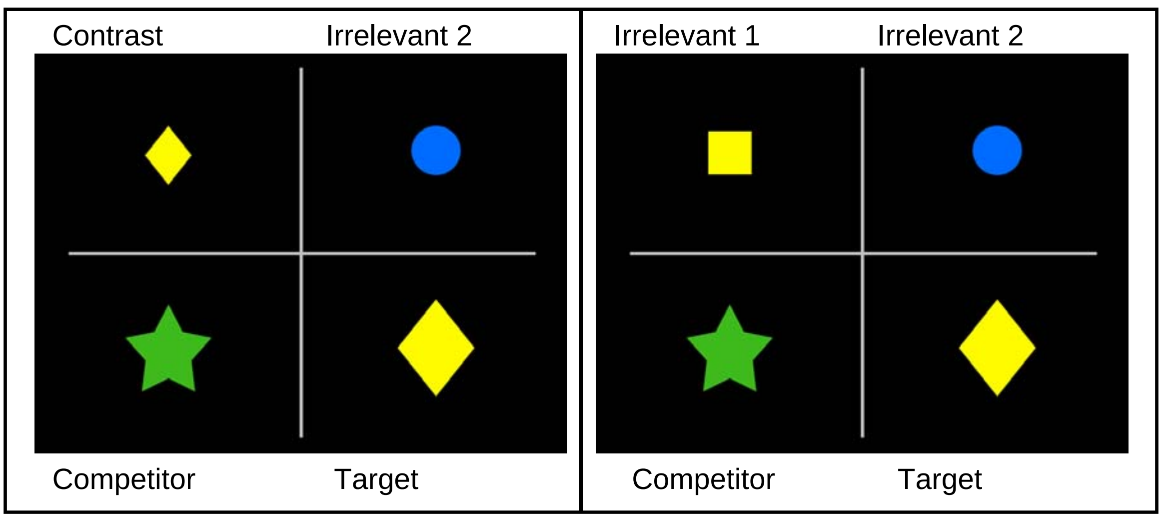

Figure 5. Example stimuli for the size group. The left panel shows contrast present and the right side shows contrast absent.

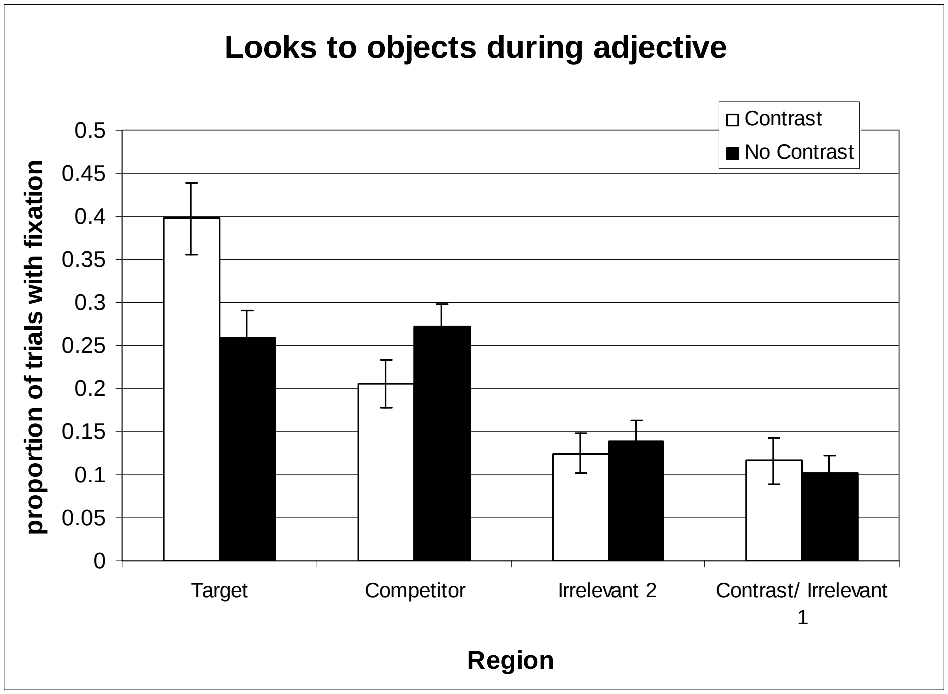

Figure 6. Proportion of trials with fixation during the modifier for size modified instructions.

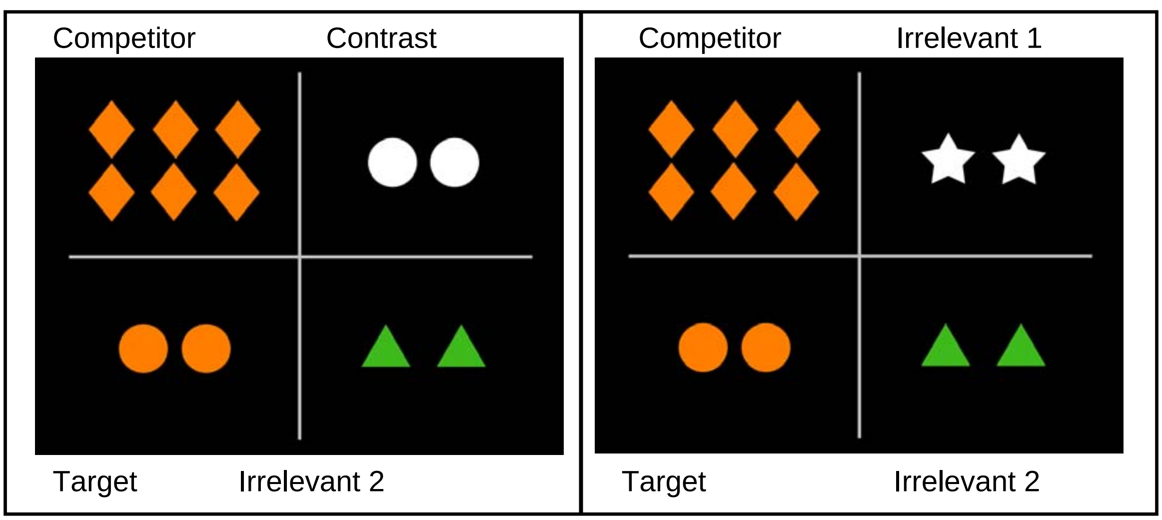

Figure 7. Example stimuli for color group. The left panel shows contrast present and the right shows contrast absent.

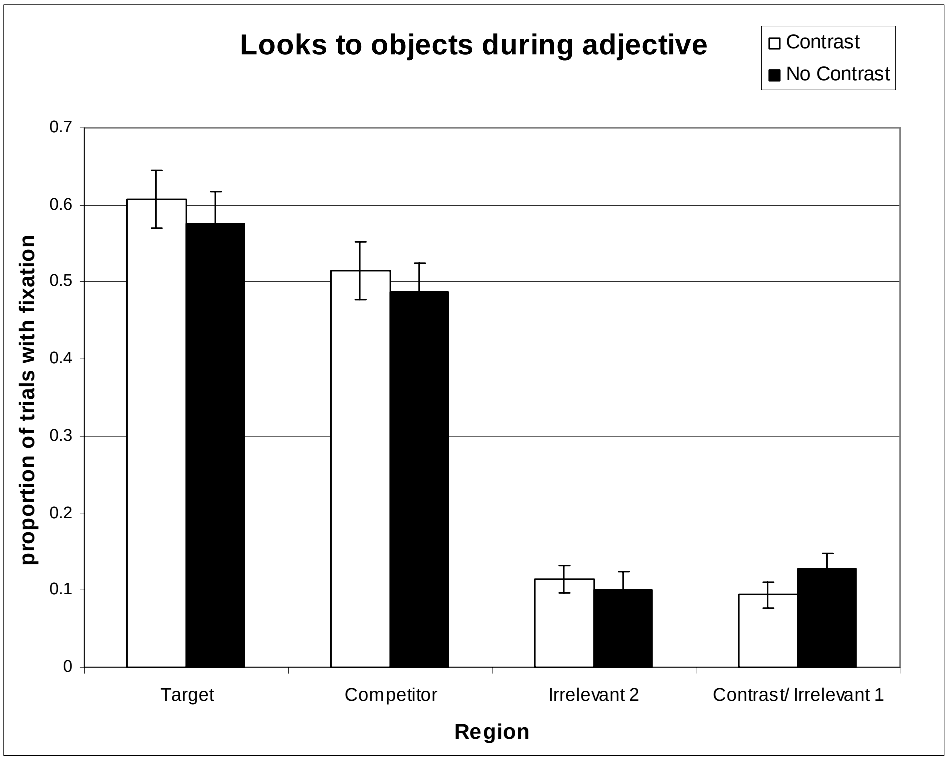

Figure 8. Proportion of trials with fixation during the modifier for color modified instructions.

A 2 x 2 (display type x modifier type) mixed model ANOVA was conducted on both the proportion of trials with a fixation and target-advantage scores (see Figure 9). The first analysis tested the proportion of trials with a fixation to the target. The results showed that both main effects were significant [display type $F1(1, 62) = 7.51$, $p < .05$, $F2(1, 34) = 7.76$, $p < .05$, & modifier type $F1(1, 62) = 5.68$, $p < .05$, $F2(1, 34) = 32.76$, $p < .05$]. The contrast present displays resulted in a higher proportion of trials with a fixation to the target, and the color modifiers had a higher proportion of trials with a fixation to the target than the size modifiers. The interaction was marginally significant by participants and not significant by items $F1(1, 62) = 5.31$, $p = .067$, $F2(1, 34) = 2.44$, $p = .13$. Looks to the target were significantly greater with the contrast-present display than with the contrast-absent display for the size modifiers $t1(31) = 3.01$, $p < .05$, $t2(17) = 3.47$, $p < .05$, and there was no difference based on contrast with the color modifiers $t1(31) = .91$, $p > .30$, $t2(17) = .83$, $p > .40$. These results replicate previous work looking at contrastive inferences on referential communication. Crucially, when the display contains a contrasting object, participants can begin to distinguish the target from the other objects in the display at a point when the instruction is still ambiguous with size modifiers.[11]

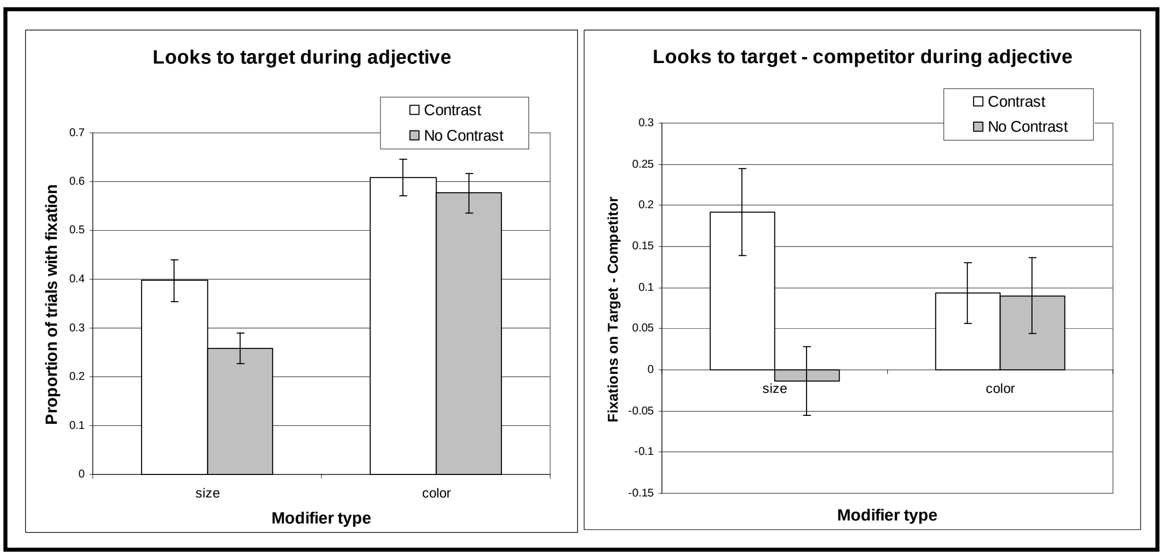

Figure 9. Results showing the looks to the target during the modifier. The left panel shows the proportion of trials with fixation to the target, and the right panel shows the target advantage scores where looks to the competitor object were subtracted from looks to the target.

The results for the target-advantage scores were slightly different. As in the previous analysis, there was a main effect of display type, in which the contrast-present

[11] I conducted further simple effects tests on all remaining objects in Figures 6 & 7. The results showed one significant difference in looks to the competitor for the size modified instructions $t1(31) = -2.09$, $p < .05$, $t2(17) = -1.37$, $p < .20$ (see Figure 6). Looks were greater when the display did not have a contrast. None of the other object comparisons were significant.

displays showed a higher target-advantage scores compared to the no contrast displays $F1(1, 62) = 5.68$, $p < .05$, $F2(1, 34) = 8.21$, $p < .05$. However, unlike the previous analysis, there was significant interaction of between display type and modifier type $F1(1, 62) = 5.31$, $p < .05$, $F2(1, 34) = 5.41$, $p < .05$. Paired comparisons contrasting display type revealed a significant difference in target advantage with size modifiers $t1(31) = 2.91$, $p < .05$, $t2(17) = 2.95$, $p < .05$, and no difference with color modifiers $t1(31) = .067$, $p > .90$, $t2(17) = .48$, $p > .60$. A second difference for the target-advantage scores was that the main effect of modifier type was not significant *F's* < 1.

In summary, there is quite a bit of overlap in the pattern of results when examining the proportion of trials with a fixation and the target-advantage scores. Display type and modifier type interact such that you see differences when a contrasting object is present for size modification, and no difference with color modification. This is the expected pattern. These results demonstrate that this task **is** sensitive to the contrastive inference originally shown by Sedivy and colleagues. I showed that participants can begin to discriminate the target from its competitor sooner when the visual display contains a contrasting object that makes a size modifier necessary. In contrast, there is no benefit to a contrasting object when participants heard an ambiguous **color** modifier. These results suggest that the linguistic system can use visual information (i.e. the presence of two objects) to anticipate the target at a point in the utterance that is ambiguous.

EXPERIMENT 2

Having established the sensitivity of the task to the contrast inference, I now turn to the primary theoretical question of interest, which concerns whether the contrastive inference with size modification can be cancelled by the presence of over-descriptions in the filler trials. If it can, then the default view of generalized implicatures would be called into question. Levinson assumes that generalized implicatures are generated by default in all contexts. Moreover, these interpretations should be available immediately and incrementally as soon as a modifier word is processed. Particularized implicatures, according to Levinson, arise later in processing, so this theory makes a very strong prediction for an initial context-independent stage, which is followed by a second somewhat slower context-sensitive stage. The alternate view assumes that representations from sentence (or literal) meaning feed directly into a single pragmatic processing mechanism (Carston, 2002; Sperber & Wilson, 1986). In this experiment, I manipulated the context to determine whether the presence of over-descriptions in the fillers can eliminate the contrastive inference that has been observed with size modification. The goal of this experiment was to delineate the default view and the context-dependent views of generalized implicature using an online measure of processing.

Grodner and Sedivy (in press) provided some evidence that contrastive inferences were not always generated. In their experiment, one group was assigned to follow instructions from an unreliable speaker, which included trials that had mislabeled objects as well a high number of over-descriptions. Participants in this condition showed negative target-advantage scores, which indicates that subjects did not converge on the target faster than the competitor. Based on this finding Grodner and Sedivy argued that listener's interpretations show immediate contextual sensitivity, suggesting that contrastive inferences can be completely eliminated. This result indicates that initial interpretations depend on the perceived cooperativeness of the speaker. One important question that comes out of this work is how do listener expectations get updated, so as to affect initial processing (i.e. what directly leads to the attenuation of the contrastive inference?). At this time it is unknown whether listeners need an explicit cue about uncooperativeness, or whether changes in interpretation can be achieved implicitly.

To investigate whether predictive inferences are observed only under relatively informative task conditions, and whether they can be eliminated, as a result of exposure to unreliability, the second experiment was a within subjects experiment that included a block variable with two levels. An informative block of trials contained few over-descriptions (~20%), and an uninformative block contained many over-descriptions (~80%). If participants are implicitly sensitive to the informativeness of modifiers across trials, then there should be a reduction in the early looks to the target in the uninformative block. More specifically, there should be anticipatory fixations similar to Experiment 1 in the informative block, and there should be an elimination of anticipatory fixations in the uninformative block. If there is no difference between the informative and uninformative blocks, then the default view of generalized implicature would be supported (Levinson, 2000). This is because Levinson assumes a specialized processing mechanism, which should be impervious to contextual modulation. However, if the presence of over-descriptions eliminates early looks to the target, then the context-driven view would be supported (Carston, 2002; Sperber & Wilson, 2002).

This experimental design will allow me to address one further issue related to how the contextual manipulation exerts its effect on processing. The issue deals with how subjects' search strategy changes when they are confronted with a high number of over-described instructions. I predict that search patterns in the informative block will be different from that in the uninformative block. More specifically, the uninformative block should show a greater tendency to search according to the feature denoted by the adjective. So if subjects hear *big*, then they will be more likely to attend to the big things in the array (i.e. the target & the competitor). In the informative block subjects should be more likely to search according to the contrasting objects in the display (i.e. the target & the contrast). This type of search strategy reflects a search based on the anticipated noun.

The main prediction for this experiment is that the informativeness of modifiers across trials should affect participant's tendency to engage in contrastive inferencing. If the informative block of trials is heard first, then the pattern in that block should be similar to the results from the previous experiment (see Figure 9). In the uninformative block, there should be a reduction in the difference between display types for the size modifiers. In the other group (i.e. the one that receives the uninformative block first), the pattern should be reversed. There should be no contrast differences in the uninformative block. If the pattern of results in the informative (second) block is like the previous experiment, then it would suggest that the processing system has the ability to adapt when task conditions switch from uninformative to informative. On the other hand, if the system cannot take advantage of the shift from uninformative to informative, then it would suggest that the processing system cannot recover from the uninformative environment. This experiment investigates whether contrastive inferences are always generated, as predicted by Levinson's default view, or whether these inferences are made only under relatively informative task conditions. The key contribution of this experiment is that it tests an implicit manipulation of informativity in a within subjects design.

METHOD

Participants. Thirty-two undergraduate psychology students from Michigan State University participated for course credit. All were native speakers of English and had normal or corrected-to-normal vision. None participated in Experiment 1.

Stimuli. Utterances were recorded in the same way as in the previous experiment. Table 5 shows the durations of modifiers and nouns for critical trials in this experiment. Comparisons of duration were not significant for either adjectives or nouns $t(35) = 1.66$, $p > .10$, and $t(35) = -.066$, $p > .90$. For this experiment, all of the visual displays contrasted size and color; therefore, for this experiment the color displays were slightly different from Experiment 1. Figure 10 shows example displays for the color contrast tested in this experiment. In the informative block, 28 filler instructions had a color modifier, 17 had a size modifier, 10 had a bare noun phrase (e.g. *point to the triangle*), and 5 had both a size and a color modifier. The two modifier instructions were paired with displays that contained 3 of one particular shape, and the contrasts were such that both modifiers were required to in order to identify the target. The bare noun phrase instructions were paired with displays that contained 4 unique shapes. In the uninformative block, 33 fillers had a color modifier, 22 had a size modifier, and 5 had both a size and a color modifier. The two modifier trials were paired with visual displays that contained 2 contrasting objects, making these instructions over-described. As in the previous experiment, to reduce any correlation between the presence of contrasting objects and pre-nominal modification, two things were done. The first was that 24 fillers contained a contrasting pair of objects and neither was the target. The second was that nine filler trials contained a modified noun phrase that referred to the competitor object in a display the one in Figure 10.

Table 5. Mean duration of adjectives and nouns in critical instructions in milliseconds. Standard Deviations are in parentheses.

	Size	Color
Adjective	360.2 (92.3)	326.0 (76.5)
Noun	1030.1 (208.2)	1032.1 (230.3)

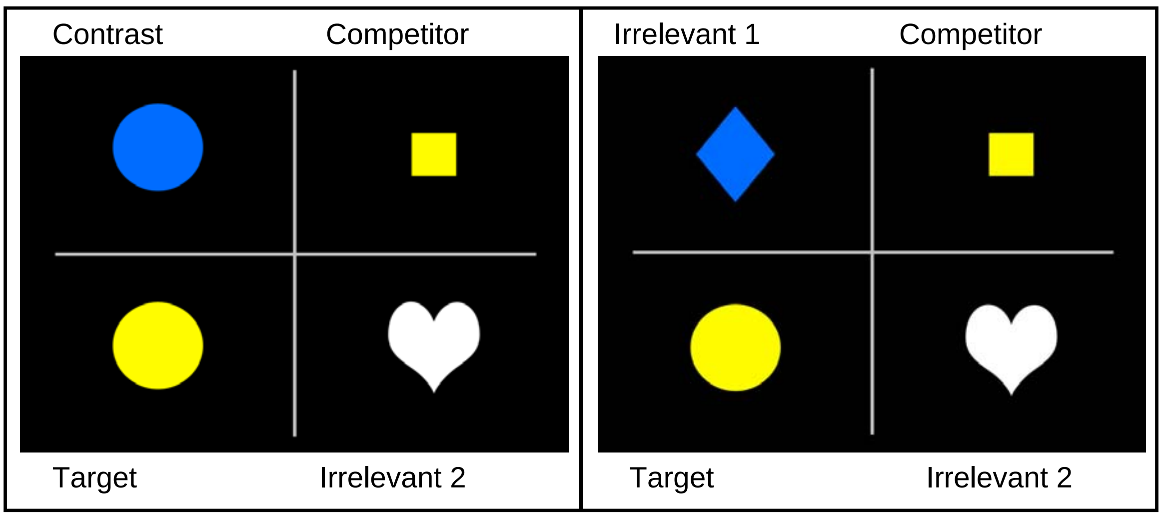

Figure 10. Example stimuli for color contrast in Experiment 2.

Apparatus. Same as Experiment 1.

Design and Procedure. The design was a 2 x 2 x 2 x 2 (display type x modifier type x informativness x block order). Display type and modifier type are the same as in the previous experiment, but here both were within subjects variables. Informativeness refers to the number of over-descriptions in the fillers trials, and was manipulated in two blocks. The informative block had few over-described filler instructions, and the uninformative block had many over-described filler instructions. Informativeness was counterbalanced across participants in a between subjects variable called *block order*.

Each block consisted of 96 trials, and in each block subjects heard 18 critical utterances for each type of modifier (i.e. size & color). Half of these trials were paired with a contrast display and half with a no contrast display.

The procedures and analysis were the same as the previous experiment, except that participants were given a short break between the two blocks of trials. The entire session lasted 30 minutes.

RESULTS and DISCUSSION

The significant results from a 2 x 2 x 2 x 2 mixed model ANOVA are presented in Tables 6 and 7. The means for looks to all four objects during the modifier are shown in Appendix B. Again all analyses were done by first examining the proportion of trials with a fixation to the target, and second by examining target-advantage scores where looks to the competitor were subtracted from looks to the target. In both analyses, the four-way interaction was not significant, but there was one significant 3-way interaction between modifier type, informativeness, and block order.

Table 6. Significant results from the 4-way ANOVA (display type x modifier type x informativeness x block order) testing proportion of trials with fixation to target.

	Subjects (F1)	Items (F2)
3-way interaction		
Modifier x Informativity x Block	$F1(1, 30) = 4.22, p < .05$	$F2(1, 34) = 3.36, p < .08$
2-way interactions		
Contrast x Block	$F1(1, 30) = 4.29, p < .05$	$F2(1, 34) = 1.56, p = .22$
Informativeness x Block	$F1(1, 30) = 5.19, p < .05$	$F2(1, 34) = 5.43, p < .05$
Main effects		

Contrast	$F1(1, 30) = 5.85$, $p < .05$	$F2(1, 34) = 1.80$, $p = .19$
Informativeness	$F1(1, 30) = 5.52$, $p < .05$	$F2(1, 34) = 3.81$, $p = .59$

Because the design is complicated, I will begin with a verbal description of the results, and then follow with the presentation of the inferential statistics. In Figure 11, the top two panels show the means for group 1, and the bottom two panels show the means for group 2. Examining these results reveals that there seems to be an important difference based on which block of trials the participant received first. Notice that in the upper left panel of Figure 11, there is a similar pattern overall as in Experiment 1. The one exception is that the proportion of trials with a fixation to the color targets is lower than before. I will present three possible reasons for this difference in the general discussion. However, as expected, there are differences based on contrast for size modifiers and no difference with the color modifiers. Moving across to the upper right panel, you can see that the overall number of looks to the target drops in all conditions. This suggests that the uninformative modifiers in the second block affect processing. However, in contrast to the main predictions, it does not seem that the over-described filler instructions eliminated the effect of contrast with the size modifiers. Moreover, there seems to be a trend of a contrast effect with the color modifiers. The bottom two panels in Figure 11 show a quite different pattern. All of the conditions fall between .25 and .19, and there is no hint of a contrast effect in any of the four possible conditions. This suggests that the presence of over-descriptions in the first block of trials can eliminate the contrastive inference.

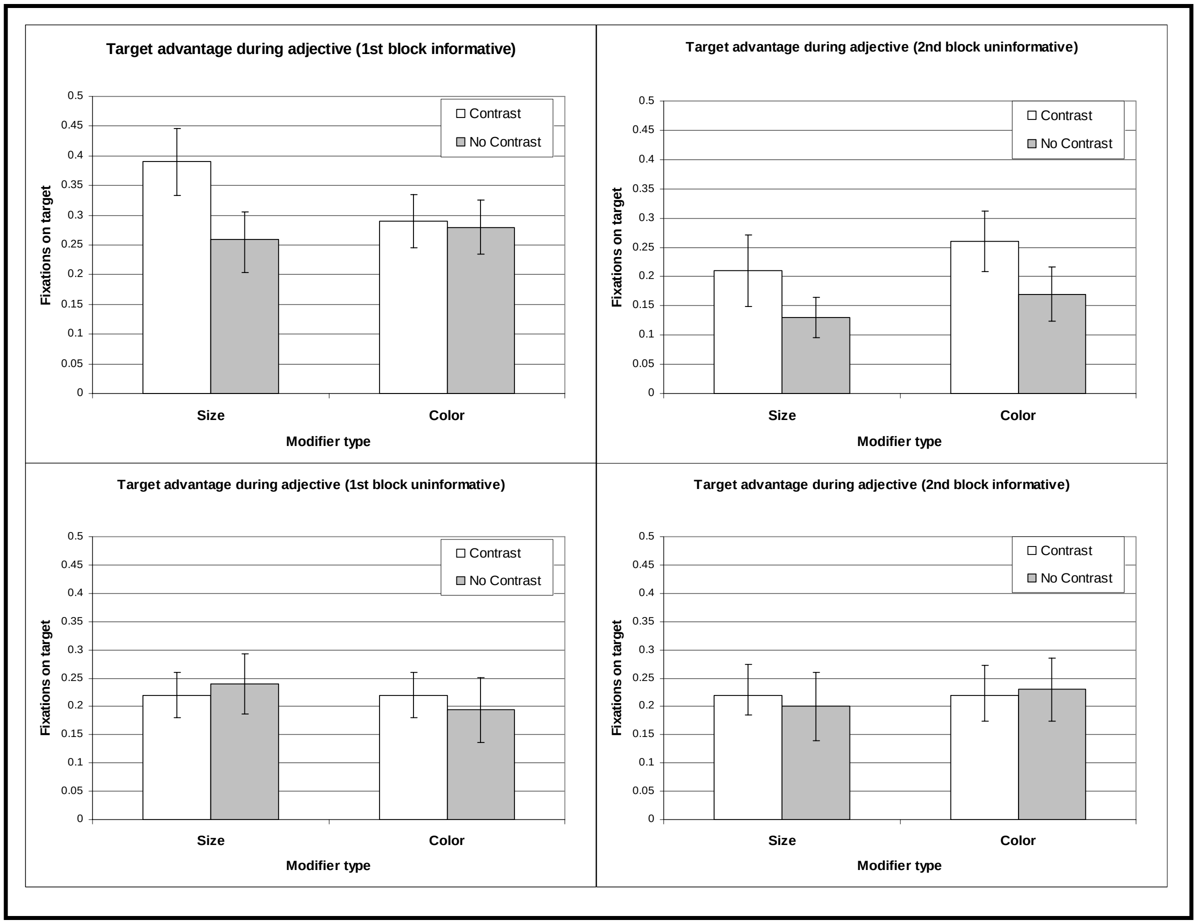

Figure 11. Means showing proportion of trials with fixation to the target in each of the sixteen conditions of the experiment. The top two panels shows the results from the group of participants who received the informative block of trials first, and the bottom two panels show the results for subjects who received the uninformative block of trials first.

Given the obvious differences between the two block orders, I decomposed the 3-way interaction between modifier type, informativity, and block order by examining each block order separately. The results of the two 2-way interactions between modifier type and informativeness revealed significant differences only for the group who received the informative block of trials first (i.e. the top two panels in Figure 11). In this group there was a main effect of informativity $F1(1, 15) = 6.04$, $p < .05$, $F2(1, 17) = .15$, $p = .70$, in which the informative block produced more looks to the target than did the uninformative block. The interaction was also significant $F1(1, 15) = 9.43$, $p < .05$, $F2(1, 17) = 5.43$, $p < .05$. Paired comparisons showed more fixations with the size modifiers in the informative block compared to the uninformative block $t1(15) = 2.87$, $p < .05$, $t2(17) = 1.21$, $p = .24$. There was also a marginal difference between the size and color modifiers in the informative block $t1(15) = -1.83$, $p = .087$, $t2(17) = -2.29$, $p < .05$. These analyses indicate that when the task environment shifts from informative to uninformative there is a significant reduction in the looks to the target for size modifiers. The effect is as predicted, however, because the 3-way interaction did not include display type I cannot conclude that the uninformative environment eliminates the contrast effect. In actuality the contrast effect is still present in the uninformative environment, and a contrast effect actually seems to emerge for color modifiers in the uninformative environment.[12] The reduction in the proportion of trials with a fixation seems to indicate that the uninformative environment mainly affects the speed with which the participants are able to identify the target. Essentially, the informativity manipulation cuts the number of trials with a fixation by about a half. There were no differences in the group who got the uninformative block first.

Continuing with the significant effects reported in Table 6, the next result was an interaction between contrast and block order. Again, given the pattern of means, it is clear that there is an effect of contrast for the participants who received the informative block of trials first $t1(15) = 3.58$, $p < .05$, $t2(17) = 2.51$, $p < .05$, whereas subjects who

[12] In the uninformative second block, the difference between contrast and no contrast displays was marginally significant for size modifiers $t1(15) = 1.77$, $p = .097$, $t2(17) = 1.98$, $p = .064$, and the difference between the contrast and no contrast display for the color modifiers was significant by subjects $t1(15) = 2.25$, $p < .05$, $t2(17) = 1.72$, $p = .104$.

received the uninformative block first showed no contrast effect $t1(15) = .22$, $p = .83$, $t2(17) = .059$, $p = .95$. This pattern of results suggests that the first block of trials has a large impact on processing even after the informativeness of modifiers changes. The second significant two-way interaction was between informativeness and block order. There is similar pattern here with a marginal difference between the informative and uninformative block for the group who received the informative block of trials first $t1(15) = 1.96$, $p = .069$, $t2(17) = 2.89$, $p < .05$, and no difference for the other group $t1(15) = .46$, $p = .65$, $t2(17) = .28$, $p = .78$. This interaction shows that the informative block of trials results in more looks to the target than does the uninformative block. However, this effect only holds for the group that heard the informative block first. There were no differences when the uninformative block was heard first.

In summary, the results from this analysis suggest that the informativity of the first block of trials has an important effect on initial interpretations even when the informativity changes mid-experiment. These results overall seem to suggest that the pattern of responding established during the initial part of the experiment has a large (and irreversible) effect on processing tendencies even when the informativeness of the task environment changes. This pattern of results indicates that subjects become entrained with a particular response strategy that is adopted early in the task, and is based on informativity. For the purposes of distinguishing the competing models, these results suggest that uninformative modifiers can eliminate the default interpretation when those uninformative modifiers are encountered early in the task, consistent with the assumptions of the contextualist view of generalized inferences.

Turning our attention to the analysis of the target-advantage scores, you can see there is quite a bit of similarity again between the two measures (compare Tables 6 & 7). The four-way interaction was again not significant, but the same three-way interaction between modifier type, informativeness, and block order was marginally significant by participants.

Table 7. Significant results from the 4-way ANOVA (display type x modifier type x informativeness x block order) testing target-advantage scores.

	Subjects (F1)	Items (F2)
3-way interaction		
Modifier x Informativity x Block	$F1(1, 30) = 3.35, p < .08$	$F2(1, 34) = 2.13, p = .15$
2-way interactions		
Contrast x Block	$F1(1, 30) = 4.21, p < .05$	$F2(1, 34) = 3.50, p = .07$
Modifier x Informativeness	$F1(1, 30) = 5.18, p < .05$	$F2(1, 34) = 4.25, p < .05$
Main effects		
Contrast	$F1(1, 30) = 3.58, p < .05$	$F2(1, 34) = 4.73, p < .05$
Modifier	$F1(1, 30) = 4.07, p = .05$	$F2(1, 34) = 3.42, p = .07$

Examining the means in Figure 12 reveals that there seems to be a general trend in which the first group (i.e. the top two panels of the figure) shows a contrast effect for three of the four possible conditions, and the other group (i.e. the bottom two panels) did not show any contrast effects. In the upper left panel of the graph you can see a similar pattern as in the first experiment and similar to the proportion of trials with a fixation. Here size modifiers show an effect of contrast, and color modifiers do not. Moving across to the upper-right panel, there is a reduction in the target advantage scores for the size modifiers. Interestingly, the uninformative modifiers in the second block seem to facilitate processing for the color modifiers with the contrast display. Like in the previous analysis, the group of participants who received the uninformative block first did not show a contrast effect in either block.

Given the similarity of the results to the previous analysis, I again decomposed the three-way interaction by examining each group separately. The results of the two 2-way interactions between modifier type and informativeness revealed significant differences only in the group, who received the informative block of trials first. In this group there was a significant interaction $F1(1, 15) = 5.21$, $p < .05$, $F2(1, 17) = 5.43$, $p < .05$. Simple effects showed marginally higher target-advantage scores with the size modifiers in the informative block compared to the color modifiers $t1(15) = -1.97$, $p = .068$, $t2(17) = -2.29$, $p < .05$. There was also a marginal difference for the color modifiers in which target advantage scores were greater in the uninformative block compared to the informative block $t1(15) = -2.36$, $p < .05$, $t2(17) = -2.00$, $p = .062$. In the other group (i.e. the bottom two panels), there was a main effect of informativity $F1(1, 15) = 4.37$, $p = .05$, $F2\ (1, 17) = 4.29$, $p = .05$, where the informative block showed higher target advantage scores than did the uninformative block.

The next significant result was an interaction between contrast and block order. There was an effect of contrast for the participants who received the informative block of trials first $t1(15) = 2.59$, $p < .05$, $t2(17) = 3.23$, $p < .05$, whereas subjects who received the uninformative block first showed no contrast effect $t1(15) = -.13$, $p = .90$, $t2(17) = .196$, $p = .85$. This pattern of results suggests that the informativity of first block of trials determines whether there will be a contrast effect in the second block. The second significant two-way interaction was between modifier type and informativity. Here the results showed a difference between size and color modifiers in the informative block $t1(15) = -2.43$, $p < .05$, $t2(17) = -2.14$, $p < .05$, but not in the uninformative block $t1(15) = -.297$, $p = .77$, $t2(17) = .42$, $p = .68$. This interaction shows that the informative block of trials results in more looks to the target compared to the competitor than does the uninformative block, and so there is a general benefit of informativeness for size modifiers.

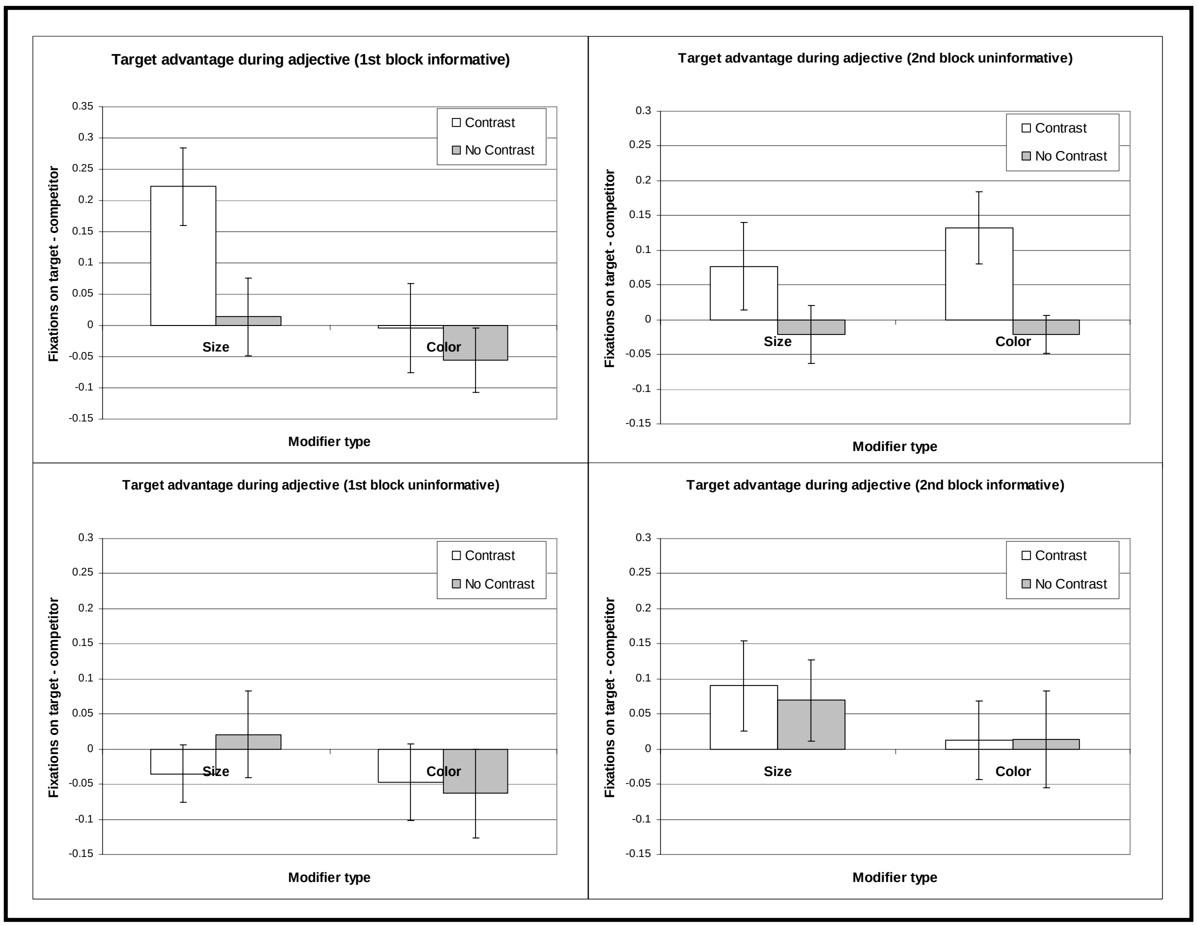

Figure 12. Means showing target advantage scores in each of the sixteen conditions of the Experiment. The top two panels shows the results from the group of participants who

received the informative block of trials first, and the bottom two panels show the results for subjects who received the uninformative block of trials first.

In summary, the results from the target advantage analysis showed a largely similar pattern as the proportion of trials with a fixation. The similarities include the same 3-way interaction, and an interaction between contrast and block. In both measures the pattern of results indicates that when the informative block of trials is heard first, subjects show the expected contrast effect with size modifiers. A similar pattern is observed even when the task changes. In contrast, when the uninformative block is heard first, subjects do not show contrast effects with either modifier, and again the pattern does not change when the task does.

To obtain a more fine-grained analysis of participants responding over the course of the experiment, I analyzed the first four and the last four critical trials in both blocks for both groups. The means for this analysis are shown in Table 8. For the first group, there were no differences between the first half and second half of trials in the informative block. In the uninformative block, it does not seem that subjects got progressively worse from the first four critical trials compared to the last four trials. In actuality, there was a slightly stronger contrast effect in the last four trials. For the second group, there was a slight improvement from the first half to the second half with both types of modifiers in the uninformative block. In the informative block, there was also no evidence to suggest that subjects got progressively better from the first half to the last half. These results are consistent with the overall results from this experiment, namely that the pattern seems to be dependent on the informativeness of the first block of trials and there is little change afterwards.

Table 8. Means showing the first half and second half of trials for each block in both groups.

	1st half				2nd half			
	Contrast		No contrast		Contrast		No contrast	
	color	size	color	size	color	size	color	size
Group 1								
1st informative								
Proportion w/fixation	.30	.31	.33	.24	.22	.27	.19	.17
Target advantage	.09	.17	.07	.03	-.07	.10	-.08	-.04
2nd uninformative								
Proportion w/fixation	.22	.19	.20	.14	.28	.27	.16	.09
Target advantage	.09	.03	-.03	-.02	.17	.11	-.03	-.08
Group 2								
1st uninformative								
Proportion w/fixation	.15	.19	.18	.29	.26	.19	.18	.21
Target advantage	-.13	-.07	-.04	.07	.01	-.03	-.07	-.01
2nd informative								
Proportion w/fixation	.24	.19	.23	.19	.19	.27	.21	.20
Target advantage	.00	.14	.03	.06	.03	.10	-.03	.04

This study tested a contextual manipulation that varied the informativity of modifiers across the experimental situation. The main prediction was that the presence of over-descriptions would eliminate the contrastive inference that has been observed with pre-nominal size modifiers (i.e. the over-descriptions should eliminate the default interpretation). The results from this experiment showed that over-descriptions **can** eliminate the early looks to target, but only in participants who were initially placed in an uninformative environment. Interestingly, when the informativity of modifiers changed half way through the experiment, it did not seem that subject's interpretations changed. Rather the results from this experiment suggest that participants establish a particular pattern of responding early in the experiment, and then they keep that pattern even after the task conditions change.

In conclusion, the primary purpose of this experiment was to differentiate two competing models of generalized implicature. More specifically, the goal was to distinguish between the models presented in panels B and C of Figure 2. The default view assumes that generalized implicatures will be available by default in all contexts. According to this model contextual information can only influence processing at a later stage. The alternate position assumes that both generalized and particularized implicatures can be modulated by contextual information. The results from this experiment are consistent with the context-dependent view.

EXPERIMENT 3

The purpose of the third experiment was to investigate a different type of contextual manipulation. The basic idea was to introduce the objects on each trial using a short linguistic context where the initial description of each object was an indefinite expression. In everyday conversations an indefinite expression is often used to introduce a new entity into the discourse (cf. Clark & Haviland, 1977; Haviland & Clark, 1974; Levinson, 2000), and so the main question I investigate in this experiment is whether introducing the objects with an indefinite expression facilitates processing with the contrast present display, and conversely, whether the indefinite introduction impairs processing with the contrast absent display.

As discussed above, reference is one of the most important functions of communication. It occurs when a speaker produces a verbal description that allows a listener to identify an object in the discourse. In most cases, a definite expression requires a salient and a given antecedent in the discourse, and so successful reference relies on shared mutual knowledge (or common ground) between a speaker and a listener (Hawkins, 1978; Stalnaker, 1978).[13] The previous experiments, as well as many other visual world studies, have assumed that an object being physically present provides the adequate conditions for the use of a definite expression (e.g. Engelhardt, Bailey, & Ferreira, 2006; Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). Consistent with this assumption, Clark and Marshall argued that visual co-presence is a fundamentally stronger form of evidence about mutual knowledge compared to discourse context (see also Clark & Carlson, 1981). This is because visual co-presence can occur simultaneously with a referring expression. In this case, what is mutually known is obvious, and the only thing a speaker needs to do is to ensure that reference is unique. In contrast, prior linguistic context can never occur simultaneously with a referring expression, so this type of context relies on memory, as well the temporal distance between first mention and the definite expression. However, the assumption that visual co-presence is a stronger form of evidence about what is mutually known has never been empirically tested.

In another line of research, Johnson-Laird and Garnham (1980) proposed a *discourse model* approach to account for the way a reader comprehends text (for similar notions see Asher & Lascarides, 2003; Gernsbacher, 1990; Heim, 1982; Kamp & Reyle, 1993; Kintsch, 1998). According to this model, a reader or a listener builds a mental model that represents the information contained in the discourse. Successful reference

[13] Clark and Marshall (1981) present two main uses of the definite article. The first is deictic and the second is anaphoric. Deictic expressions are expressions that point to a specific entity or object in the shared physical world. The most common examples include demonstratives such as *this* or *that*. Anaphoric expressions in contrast are used to refer to entities or objects in the discourse or conversational context. The most common examples include definite pronouns and definite descriptions.

occurs when a single object in the mental representation is uniquely selected. At this time, we do not know whether an object in a mental discourse model has the same status as an object that is visually co-present when a listener attempts to assign reference. If there is some fundamental difference between visual co-presence and being in the linguistic discourse, then it is possible that objects introduced into the discourse with an indefinite expression might have an effect on the subsequent interpretation of a definite expression. If so, then assigning reference may be facilitated by an indefinite linguistic introduction. It also follows that processing an over-described instruction may be further impaired when the linguistic context contains no contrasting objects. That is, if a listener constructs a mental model of unique objects, then encountering a pre-nominal modifier might lead to additional processing difficulty when compared to the situation in which unique objects are visually co-present.

The previous two experiments investigated the processing of pre-nominal modifiers when the display contained a contrasting object and when it did not. In this experiment, I kept all of the task parameters the same except that I added a short linguistic context to determine whether introducing the objects with an indefinite expression creates a different type of mental representation compared to the situation where objects are only visually present. If linguistic context is fundamentally different from visual co-presence, then I expect processing of the definite descriptions to be facilitated with the contrast display, and impaired with the no contrast display.

The main prediction for this experiment is that if four unique objects are introduced by a linguistic context, then the presence of a contrastive modifier should lead to additional difficulty in identifying the target. It could also be the case that introducing two objects of the same type might speed up processing of a pre-nominal modifier. If these predictions are observed, then introducing the objects with an indefinite expression should make the over-described utterances (i.e. no contrast displays) even worse. Therefore, there should be fewer fixations on the target and lower target-advantage scores in the no contrast condition. If the linguistic introduction facilitates processing with the contrast displays, then there should be more fixations on the target and higher target-advantage scores with the contrast displays. This experiment should reveal if there are additional costs and benefits to referential processing when objects are initially introduced with an indefinite expression.

METHOD

Participants. Thirty-two undergraduate psychology students from Michigan State University participated for course credit. All were native speakers of English, and had normal or corrected-to-normal vision. None participated in Experiments 1 or 2.

Stimuli. Utterances were recorded in the same way as the previous experiments. For this experiment, however, short linguistic introductions were created for each display. Examples of these introductions are provided in Table 9. The key feature was that the objects were introduced with indefinite expressions. (Note that for plural noun phrases the indefinite article is null.) Example visual displays are repeated in Figure 13. The experiment consisted of three practice trials and 96 regular session trials (36 experimental & 60 fillers). The experimental trials consisted of 18 color modified instructions and 18 size modified instructions. Two lists were created so that for each critical utterance, two visual displays were possible; each instruction occurred once in each list, and lists were counterbalanced so that each subject saw an equal number of trials for each of the four conditions. The durations of modifiers and nouns for critical trials are given in Table 10, and *t*-tests comparing size and color were not significant for modifiers or nouns $t(17) = -1.78$, $p > .10$ and $t(17) = .05$, $p > .90$.

Table 9. Example introductory contexts for the displays shown in Figure 13.

<u>Color modifier</u>
(1) Contrast: *In the next display, you will see two circles, a square, and a heart.*
(2) No contrast: *In the next display, you will see a diamond, a square, a circle, and a heart.*

<u>Size modifier</u>
(3) Contrast: *In the next display, you will see two diamonds, a circle, and a star.*
(4) No contrast: *In the next display, you will see a square, a circle, a star, and a triangle.*

The visual displays were designed such that the target, competitor, and distractor objects had an equal probability of appearing in each of the four quadrants. In this expeirment, 28 filler instructions had a color modifier, 17 had a size modifier, 10 had a bare noun phrase (e.g. *point to the triangle*), and 5 had both a size and a color modifier (e.g. *point to the big red circle*). The two-modifier instructions were paired with displays that contained 3 of one particular shape, and the contrasts were such that both modifiers were required to in order to identify the target. The bare noun phrase instructions were paired with displays that contained 4 unique shapes. The same controls were utilized to eliminate any correlation between the presence of contrasting objects and pre-nominal modification. The visual angles and viewing distances were the same as in the previous experiments.

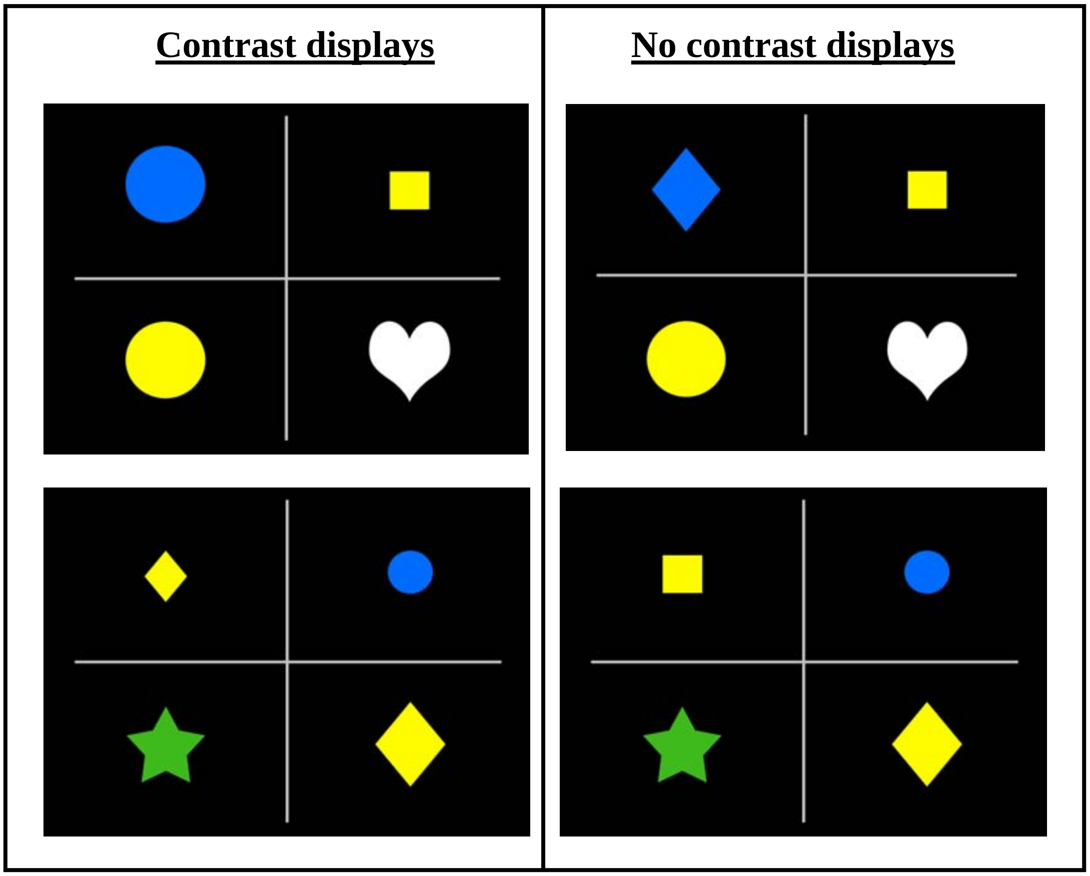

Figure 13. Example stimuli for the third experiment showing size and color, as well as contrast present and contrast absent displays.

Table 10. Mean duration of adjectives and nouns in critical instructions in milliseconds. Standard Deviations are in parentheses.

	Size	Color
Adjective	349.78(99.5)	320.67(63.6)
Noun	1176.78(100.2)	1178.94(168.4)

Apparatus. Same as Experiment 1.

Design and Procedure. The design was 2 x 2 (display type x modifier type). Display type and modifier type were manipulated within subjects. The procedures for this experiment were the same as the previous two experiments. The only difference was that participants were told that on every trial they would first hear a description of four objects. After that, the objects would appear on the screen, and then they would hear a simple instruction such as *point to the big diamond.* Participants were asked to point to the target as quickly as possible without making mistakes. The basic sequence for each trial is shown in Figure 14, and the entire session lasted approximately 30 minutes.

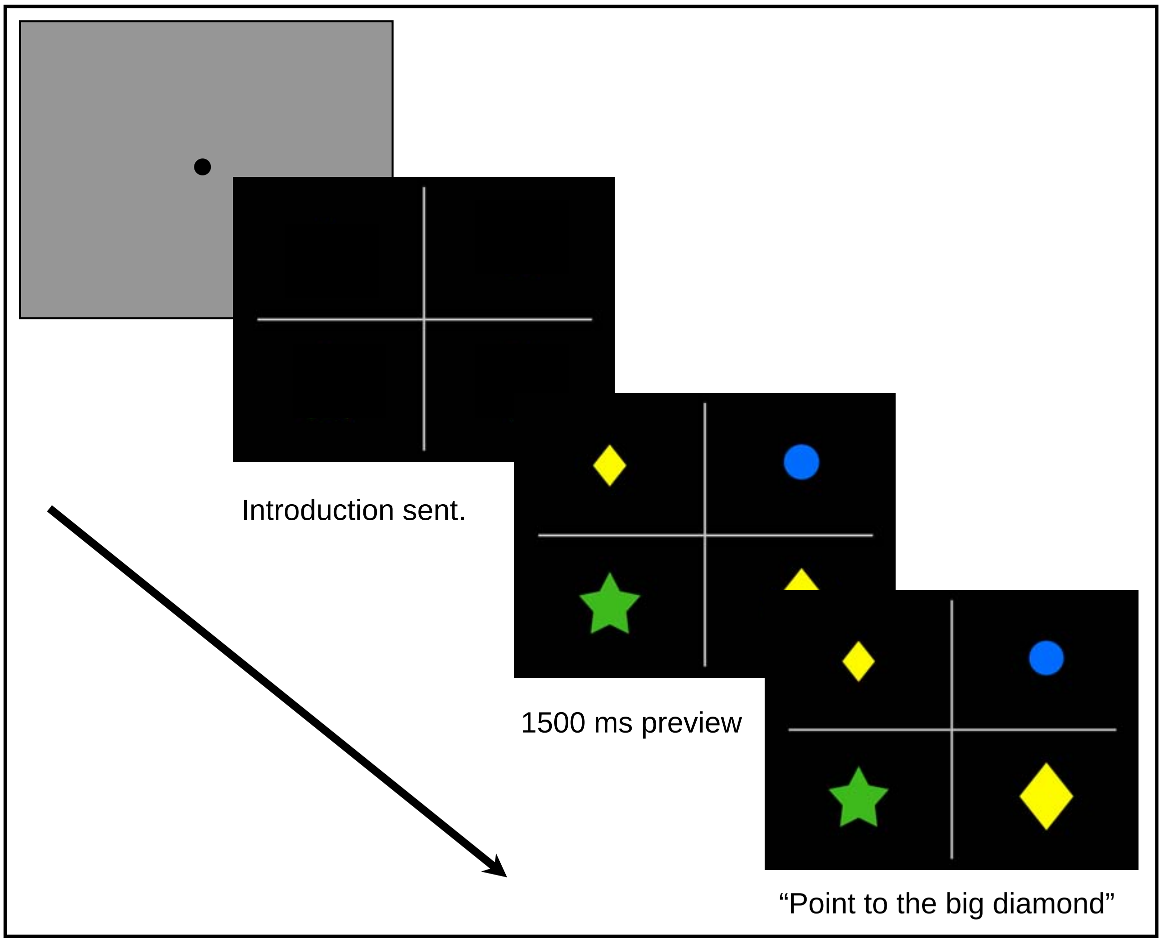

Figure 14. Trial sequence for Experiment 3.

RESULTS AND DISCUSSION

A 2 x 2 (display type x modifier type) repeated measures ANOVA was conducted on both the proportion of trials with a fixation to the target and target-advantage scores (see Figure 15). The first analysis tested the proportion of trials with fixation to the target. The results showed only a marginal interaction $F1(1, 31) = 1.96$, $p = .17$, $F2(1, 17) = 1.43$, $p = .25$. The overall pattern was similar to the first experiment, where there is a marginal effect of contrast for the size modified instructions ($p = .12$), and no difference with the color modified instructions ($p = .93$). The main difference between this result and the first experiment is that there was a reduction in the proportion of trials with a fixation to the target for the contrast displays with the size modifiers. The other three conditions are very similar to the informative first block in Experiment 2.

The results for the target-advantage scores were different. There was a main effect of modifier type, in which the size modifiers resulted in higher target advantage scores $F1(1, 31) = 4.34$, $p < .05$, $F2(1, 17) = 2.37$, $p = .14$. There was also significant interaction of between display type and modifier type $F1(1, 31) = 5.13$, $p < .05$, $F2(1, 17) = 3.45$, $p = .08$. Simple effects comparisons revealed a significant difference between the contrast and no contrast displays with size modifiers $t1(31) = 2.20$, $p < .05$, $t2(17) = 2.79$, $p < .05$. There was also a difference between the two modifiers with the contrast display $t1(31) = -2.80$, $p < .05$, $t2(17) = -3.40$, $p < .05$.

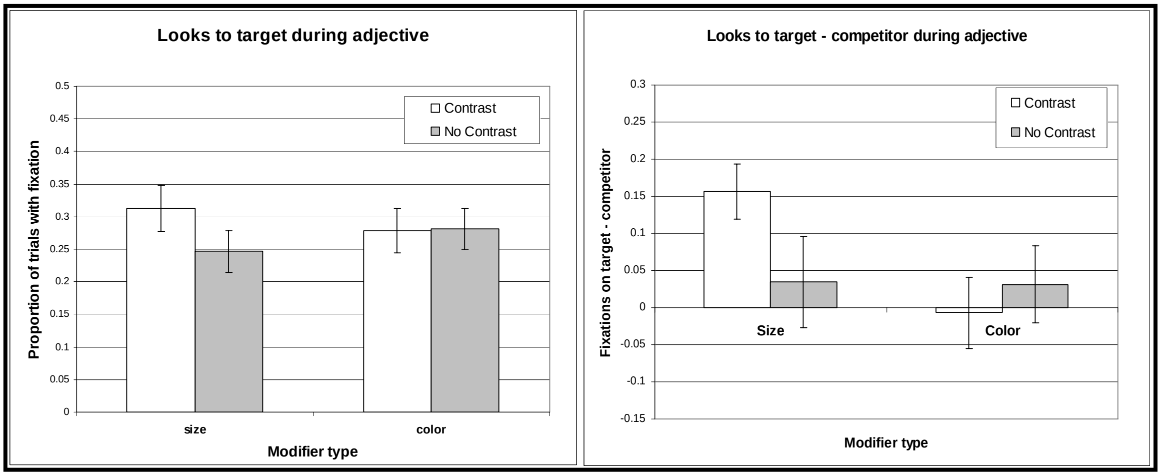

Figure 15. Results showing the looks to the target during the modifier. The left panel shows the proportion of trials with fixation to the target, and the right panel shows the target advantage scores where looks to the competitor object were subtracted from looks to the target.

In summary, the results from this experiment pattern overall resemble the results from the first two experiments. The main difference seems to be a reduction in the proportion of trials with a fixation to the target with the size modifiers in the contrast condition. Recall that the main prediction for this experiment was that if there is a fundamental difference between an object being visually co-present compared to being in the linguistic discourse, then introducing the objects with an indefinite expression should facilitate processing for the non-overdescribed instructions, and it should impair processing with the over-described instructions. The results do not support these predictions because there was a lower target advantage score in the size-contrast condition, and higher target advantage scores in the color-contrast and the color-no contrast conditions when compared to Experiment 2. However, none of the between experiment comparisons reached statistical significance ($p > .05$). These results then seem to suggest that there is no added benefit to with linguistic introduction, and that visual co-presence provides sufficient evidence to support the use of the definite determiner. This finding is consistent with the assumption that shared physical context is strong source of information about common ground (Clark & Marshall, 1981).

GENERAL DISCUSSION

The current experiments investigated two main questions. The first was whether contrastive inferences are based on default interpretations, as proposed by Levinson, or whether referential contrast effects are due to a single context-driven mechanism, as suggested by Sperber and Wilson. The second question dealt with whether visual co-presence is a sufficient type of evidence for the use of the definite determiner. The results from the second experiment showed that the inclusion of unnecessary modifiers did eliminate the contrastive inference that was shown in Experiment 1. This result compromises the automaticity assumption of generalized implicature as conceived by the default view. The results from the third experiment produced a somewhat weaker pattern of results compared to the first experiment. However, the interaction between modifier type and display type was significant for the target-advantage scores in the third experiment. This replication indicates that the linguistic contexts, which introduced the objects using indefinite expressions, have little effect on the processing of the critical instructions. It also appears that the linguistic context did not affect the search patterns when compared to the results from the first experiment (see Appendix C).

There are a couple of issues with the data that I will address before proceeding with the discussion of how the current results expand our understanding of the architecture of the pragmatic system. The first issue is the reduction in the number of trials with a fixation to the color targets (i.e. ~.60 vs. ~.30) from the first experiment compared to the other two (see Figure 9 vs. Figures 11 & 15). There are three possible reasons for the difference. The first is that the color modifiers in the first experiment were substantially longer than the other two experiments (514 ms vs. 323 ms). As a result of a longer time window you would expect a higher proportion of trials with a fixation. The second reason is that the color trials in the first experiment were intermixed with fillers that contained either number modifiers or color modifiers. In the second and third experiments, the critical trials and fillers trials contained size and color modifiers. As discussed in section 2.1, size modifiers are relative, and so size modifiers are conceptually more complex than either number or color, both of which have fixed values. Therefore, the overall task difficulty is slightly higher in the final two experiments. The third reason that could account for the reduction in fixations is that there were more over-descriptions in the experiments that manipulated size and color in a within subjects design. As we know from the results of the second experiment, more over-descriptions lead to a decrease in the speed of identifying the target, and so this could contribute to the lower number of trials with a fixation to the target. I assume that the first reason is likely the most important. However, the length of the modifier should not affect whether or not a contrastive inference is generated with a color modifier.

The second issue with the data concerns the apparent contrast effect in the color condition in the uninformative block in Experiment 2 (i.e. the upper-right panels of Figures 11 & 12). I think the likely explanation here is that participants have a tendency to slow down in the uninformative block, so it must be the case that when the processing system slows, it can then take advantage of the contrasting (color) object. Examining the means in Appendix B reveals that the effect is primarily driven by a reduction in looks to the competitor, rather than a change in looks to the target. This is actually a very interesting result because it is the opposite of my predictions. I predicted that in the uninformative block subjects would be more likely to attend to the target and to the competitor because these are the objects that match the modifier. Surprisingly, the color modifiers in the uninformative block pattern quite closely to the size modifiers in the informative block. Recall that Sedivy et al. did not get a contrast effect with color, except when the color contrast included objects that were not their prototypical color (e.g. a purple banana). The color contrast effect observed in the second experiment is intriguing because it opens up the possibility that the contrastive inference might in some way be influenced by the speed of processing, rather than strictly based on the presence of a contrasting object.

The primary purpose of this work was to investigate one of the key theoretical debates in pragmatics, namely whether is there an initial default stage for generalized implicature. The two main classes of models make competing predictions. Levinson assumes that generalized implicatures are made automatically and independent of context. Relevance theory in contrast, assumes that all pragmatic inferences takes place in a single stage that is open to contextual modulation. The main test of these competing predictions was made in Experiment 2. The results from that experiment showed that the contrastive inference could be eliminated when subjects heard uninformative modifiers in the first block of trials. Moreover, when the task changed, such that the majority of trials had informative modifiers, the contrastive inference was not observed.

In this experiment, participants were not given any information about the instructions they would hear, other than that they would have to point to a target on the computer screen as quickly as possible. Therefore, one of the main contributions of this experiment is to show that the contrastive inference can be eliminated with an implicit manipulation of informativity. Recall that Grodner and Sedivy manipulated the number of over-descriptions in the filler trials; however, participants in their study were explicitly told that the instructions were recorded from a person with a neurological disorder. It is also important to note that their experiment had several instances in which objects were mislabeled and several instances in which locations were mislabeled. It was not known, if participants needed the explicit cue to uncooperativeness or whether an implicit manipulation of informativity would be sufficient to eliminate the contrastive inference.

The results from the current experiments indicate that it is not the explicit cue to uncooperativeness (or unreliability) that leads to the reduction in anticipatory fixations. Rather it seems that subjects track or attend to the likelihood of modifiers being used contrastively over the course of the experiment. If this were the case, then we might expect graded effects over the course of the experiment. However, when I examined the first half and second half of critical trials, there was little difference suggesting that subjects adopt a particular response strategy, and then they do not change as the experiment does. Also, post-experiment interviews did not indicate that subjects explicitly picked up on the fact that one block of trials had over-descriptions and the other did not. Based on these findings, it seems that the pragmatic system is implicitly sensitive to the contrastive use of modification. Furthermore, there was no evidence in these experiments to suggest that the contrastive inference was generated and then cancelled. These data suggest that the initial processing of generalized inferences can be influenced by the context, and they do not show any of the automaticity predicted by the default view.

The third experiment involved a different type of contextual manipulation. The main idea here was to determine if there was some effect associated with the definite determiner of the key referential expressions tested in Experiments 1 and 2. To investigate this issue, I preceded each trial with a short linguistic context that introduced the objects using indefinite expressions. The main prediction was that if there is a fundamental difference between discourse context and visual co-presence then the processing of contrastive modifiers might be facilitated by the linguistic introduction. The results from this experiment showed little difference from the previous two, and as a result, I concluded that physical co-presence is a sufficient source of information to support the use of the definite determiner. This result is consistent with the arguments made by Clark and Marshall (1981), and suggests that a definite description can be felicitously used to identify a co-present visual object.

Conclusion

The results from these three studies support the recent body of experimental research suggesting that generalized implicatures are not computed by default. These data contribute to the existing literature by showing that subjects **are** implicitly sensitive to the informativity of modifiers. These findings corroborate the other work that investigated the processing of scalar implicatures (Bott & Noveck, 2004). Returning to the schematic diagrams that were presented in Figure 2, the data presented here support a processing architecture like the one shown in panel C. This model assumes that both generalized and particularized implicatures can be affected by the context in which they occur. The title of this work includes a question, “Do uninformative environments eliminate default interpretations?”, I hope to have convinced you that the answer to this question is likely "yes".

References

Asher, N., & Lascarides, A. (2003). *Logics of Conversation.* Cambridge University Press, Cambridge, England.

Altmann, G. T., & Kamide, Y. (1999). Incremental interpretation at verbs: Restricting the domain of subsequent reference. *Cognition, 73(3),* 247–264.

Altmann, G. T., & Kamide, Y. (2004). Now you see it, now you don't: Mediating the mapping between language and the visual world. In J. M. Henderson & F. Ferreira (Eds.), *The interface of language, vision, and action* (pp. 347-386). New York: Psychology Press.

Bache, C. (1978). *The order of premodifying adjectives in present-day English.* Odense: Odense University Press.

Bach, K. (1995). Standardization vs. conventionalization. *Linguistics and Philosophy, 18,* 677-686.

Bezuidenhout, A. L., & Cutting, J. C. (2004). Implicature, relevance and default inferences. In I. Noveck & D. Sperber (Eds.), *Experimental Pragmatics.* Basingstoke: Palgrave Macmillan.

Bezuidenhout, A. L., & Morris, R. K. (2004). Implicature, relevance and default pragmatic interpretation. In I. Noveck, & D. Sperber (Eds.),, *Experimental Pragmatics.* Basingstoke: Palgrave Macmillan.

Bierwisch, M. (1987). The semantics of gradation. In: Bierwisch, M. Lang, E. (Eds.), *Dimensional Adjectives.* Springer, Berlin.

Bott. L., & Noveck, I. A. (2004). Some utterances are underinformative: The onset and time course of scalar inferences. *Journal of Memory and Language, 51,* 437-457.

Breheny, R., Katsos, N., & Williams, J. (2006). Are generalized scalar implicatures generated by default? An on-line investigation into the role of context in generating pragmatic inferences. *Cognition, 100,* 434-463.

Carston, R. (1995). Quantity maxims and generalized implicature. *Lingua,* 96, 213-44.

Carston, R. (2002). *Thoughts and utteranctes.* Oxford: Blackwells.

Chierchia, G. (2004). Scalar implicatures, polarity phenomena, and the syntax/pragmatics interface. In A. Belletti (Ed.). S*tructures and Beyond.* Oxford: Oxford University Press.

Clark, H. H., & Carlson, T. B. (1981). Context for comprehension. In J. Long & A. Baddeley (Eds.), *Attention and performance IX* (pp. 313-330). Hillsdale, NJ Erlbaum.

Clark, H. H., & Haviland, S. (1977). Comprehension and the given-new contract. In R. Freedle (Ed.), *Explaining linguistic phenomena.* Washington: Hemisphere.

Clark, H. H., & Marshall, C. R. (1981). Definite reference and mutual knowledge. In A. K. Joshi, B. L. Webber, & I. A. Sag (Eds.), Elements of discourse understanding. Cambridge: Cambridge University Press.

Deutsch, W., & Pechmann, T. (1982). Social interaction and the development of definite descriptions. *Cognition, 11,* 159-184.

Engelhardt, P. E., Bailey, K. G. D., & Ferreira, F. (2006). Do speakers and listeners observe the Gricean maxim of quantity. *Journal of Memory and Language, 54,* 554- 573.

Engelhardt, P. E., Xiang, M., & Ferreira, F. (2008). Anticipatory eye movement mediated by word order constraints. *Proceedings of the 30th Annual conference of the Cognitive Science Society*. Washington, D.C.

Epstein, R. (1998). Reference and definite referring expressions. *Pragmatics & Cognition, 6,* 189–207.

Ferris, C. (1993). *The meaning of syntax: a study of adjectives in English*. London & New York: Longman.

Gazdar, G. (1979). *Pragmatics: Implicature, presupposition and logical form.* New York: Academic Press.

Gernsbacher, M. A. (1990). *Language comprehension as structure building.* Hillsdale, NJ: Erlbaum.

Grice, P. (1967). Logic and Conversation. William James Lectures. Ms., Harvard University.

Grice, P. (1975). Logic and Conversation. In P. Cole & J. Morgan (Eds.), *Syntax and semantics: Speech acts* (Vol. III, pp. 41-58).

Grice, P. (1989). *Studies in the ways of words.* Cambridge, MA: Harvard University Press.

Grodner, D., Klein, N., Carbary, K., & Tanenhaus, M. K. (March, 2008). Experimental evidence for rapid interpretation of pragmatic "some". Paper presented at the 21st Annual Meeting of the CUNY conference on Human Sentence Processing. Chapel Hill, NC.

Grodner, D., & Sedivy, J. (in press). The effects of speaker-specific information on pragmatic inferences. *The Processing and Acquisition of Reference.* Eds. N. Pearlmutter, and E. Gibson. Cambridge MA: MIT Press.

Haviland, s. E., & Clark, H. H. (1974). What's new? Acquiring new information as a process in comprehension. *Journal of Verbal Learning and Verbal Behavior, 13,* 512-521.

Hawkins, J. A. (1978). *Definiteness and Indefiniteness: A study in reference and grammaticality prediction.* London: Croom Helm.

Hiem, I. (1982). The semantic of definite and indefinite NPs. Ph. D. Dissertation, University of Massachusetts at Amherst. GLSA, Amherst, MA.

Horn, L. (1984). Toward a new taxonomy for pragmatic inference: Q–based and R-based implicature. In Schiffrin, D. (Ed.), *Meaning, form, and use in context: linguistic applications (GURT '84),* pp. 11--42. Washington: Georgetown University Press.

Horn, L., (2004). Implicature. In L. Horn and G. L. Ward (Eds.). *Handbook of Pragmatics.* Pp. 1-46, Oxford: Blackwell.

Huang, Y. T., & Snedeker, J. (in press). From meaning to inference: Evidence for the distinction between lexical semantics and scalar implicature in online processing and development.

Johnson-Laird, P. N., & Garnham, A. (1980). Descriptions and discourse models. *Linguistics and Philosophy, 3,* 371-393.

Kamp, H. (1975). Two theories about adjectives. In E. L. Keenan (Ed.), *Formal Semantics for Natural Languages,* Cambridge, UK: Cambridge University Press (pp. 123-155).

Kamp, H., & Partee, B. (1995). Prototype theory and compositionality. *Cognition, 57,* 129-191.

Kamp, H., & Reyle, U. (1993). *From Discourse to Logic*. Kluwer, Dordrecht.

Kintsch, W. (1998). *Comprehension: A paradigm for cognition.* New York: Cambridge University Press.

Levison, S. C. (2000). *Presumptive meanings: The theory of generalized conversational implicatures.* Cambridge, MA: MIT Press.

Noveck, I. A., & Posada, A. (2003). Characterizing the time course of an implicature: An evoked potentials study. *Brain and Language, 85,* 203-210.

Pechmann, T. (1989). Incremental speech production and referential overspecification. *Linguistics, 27,* 89-110.

Prince, E. F. (1978). "On the function of existential presupposition in discourse." In *Papers from the 14th Regional Meeting, Chicago Linguistics Society*. Chicago Linguistics Society, University of Chicago, pp. 362-376.

Richards, M. M. (1977). Ordering preferences for congruent and incongruent English adjectives in attributive and predicative contexts. *Journal of Verbal Learning and Verbal Behavior, 16,* 489-503.

Sedivy, J. C. (March, 1999). Examining the discourse-based properties of adjectives in on-line semantic processing. Paper presented at the Twelfth Annual CUNY Conference on Human Sentence Processing, New York.

Sedivy, J. C. (2003). Pragmatic versus form-based accounts of referential contrast: Evidence for effects of informativity expectations. *Journal of Psycholinguistic Research, 32,* 3-23.

Sedivy, J. C. (2006). Evaluating explanations for referential context effects: Evidence for

Gricean mechanisms in online language interpretation. In *Approaches to World-Situated language use: Bridging the Language-as-product and Language-as-action traditions (learning, development, and conceptual change).* In J. C. Trueswell and M. K. Tanenhaus (Eds.), Cambridge MA: MIT Press.

Sedivy, J. (2007). Implicature during real time conversation: A view from language processing research. *Philosophy Compass, 2,* 475-496.

Sedivy, J. C., Tanenhaus, M. K., Chambers, C. G., & Carlson, G. N. (1999). Achieving incremental semantic interpretation through contextual interpretation. *Cognition, 71,* 109-147.

Siegel, M. (1980). *Capturing the Adjective.* New York: Garland.

Sperber, D., & Wilson, D. (1986). *Relevance.* Oxford: Blackwell.

Sperber, D., & Wilson, D. (2002). Pragmatics, modularity, and mind-reading. *Mind and Langauge, 17,* 3-23.

Stalnaker, R. C. (1978) "Assertion." In P Cole (Ed.), *Syntax and Semantics,* Vol. 9, *Pragmatics.* New York: Academic Press, pp. 315-332.

Tanenhaus, M. K., Spivey-Knowlton, M. J., Eberhard, K. M., & Sedivy, J. C. (1995). Integration of visual and linguistic information in spoken language comprehension. *Science, 268,* 1632-1634

Zipf, G. K. (1949). *Human Behavior and the Principle of Least Effort.* Cambridge, MA: Addison-Wesley.

APPENDIX A

The results showing the proportion of trials with fixation to each of the four objects in the display during the noun for Experiment 1. As you can see in Figure A, the pattern of means in looks to the target reverses from the modifier time window. The advantage here with the no contrast display is likely due to a catching up effect. Figure B shows the looks for the color modified instructions. During this time window there was no difference in looks to the target based on display, and so this pattern is similar to the pattern that was observed during the modifier.

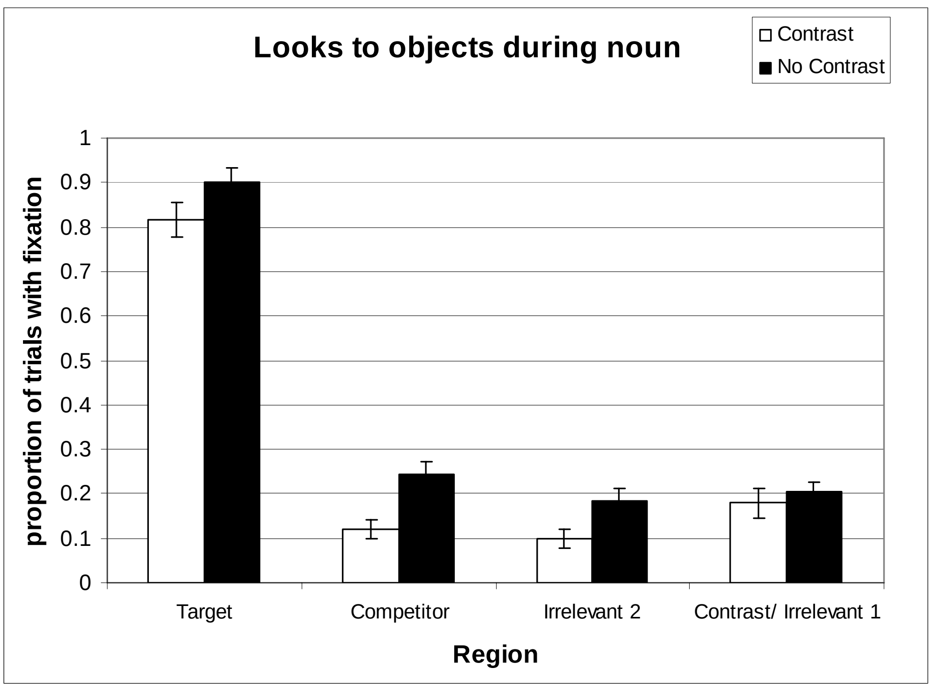

Figure A. Proportion of trials with a fixation during the noun time window for size modified instructions.

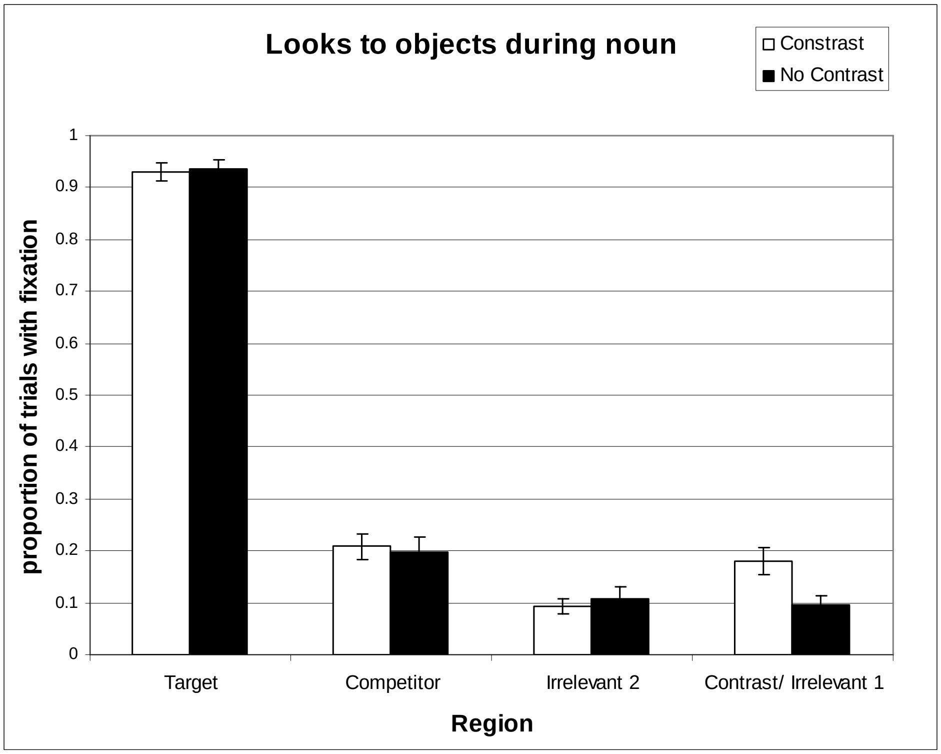

Figure B. Proportion of trials with a fixation during the noun time window for color modified instructions.

Appendix B

The results showing the proportion of trials with fixation to each of the four objects during the modifier time window for Experiment 2. Figures C and D shows the results for the group who received the informative block of trials first. In these two figures you can see the expected pattern of results. Looks to the target are greater than to the competitor for the size modifiers with contrast display, and no difference between target and competitor in the size-no contrast condition. In Figure D, there is actually more looks to the competitor than to the target for both display types. Figures E and F show the results for the uninformative block for the same group of participants. Here the pattern of means shows quite a bit of similarity between the two modifier types. There is a target advantage compared to the competitor for both modifiers with contrast display. With the no contrast displays, looks to the competitor were greater than looks to the target. The means for the group that received the uninformative block of trials first are shown in Figures G – J. Beginning with the uninformative block you can see that there is no advantage for the target compared to the competitor in any of the four possible conditions, which suggests that the uninformative modifiers can eliminate the contrastive inference. Interestingly, when the modifiers in the filler trials shift from uninformative to informative there seems to be a tendency to attend to the target over the competitor (this trend is more pronounced with size modifiers than with color modifiers), but there is no difference based on display type. Again, I am going to appeal to a simple speed explanation for the increase in target-advantage for the informative second block. However, if you compare looks to the contrast object in Figures G and J, then you can see that there some tendency to attend to the contrast more in the informative block than in the uninformative block. This results indicates that there is some shift in strategy based on informativeness.

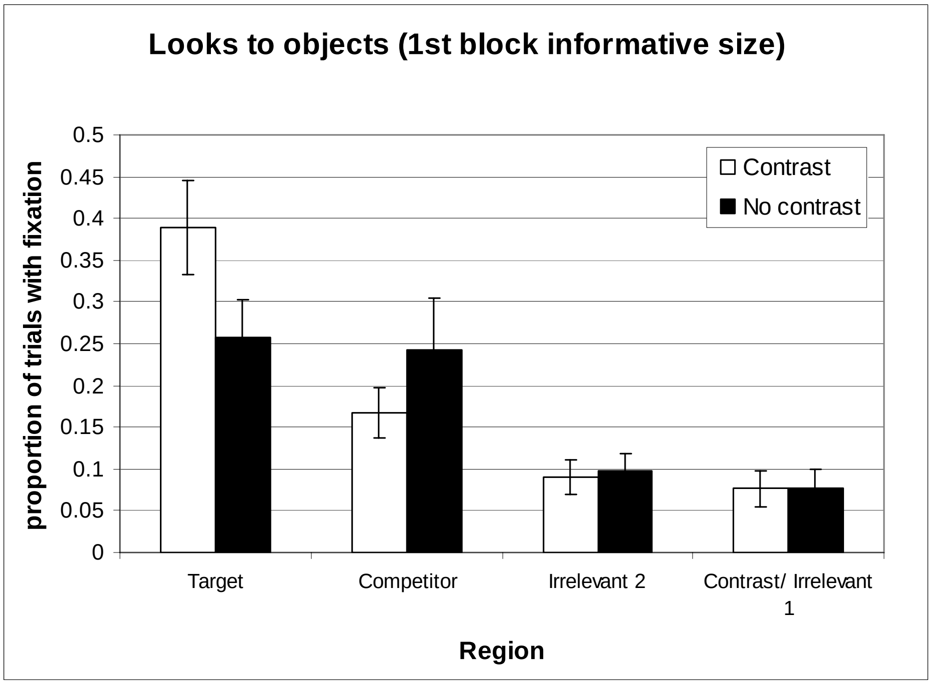

Figure C. Proportion of trials with a fixation to each of the four objects in the display for size modified instructions.

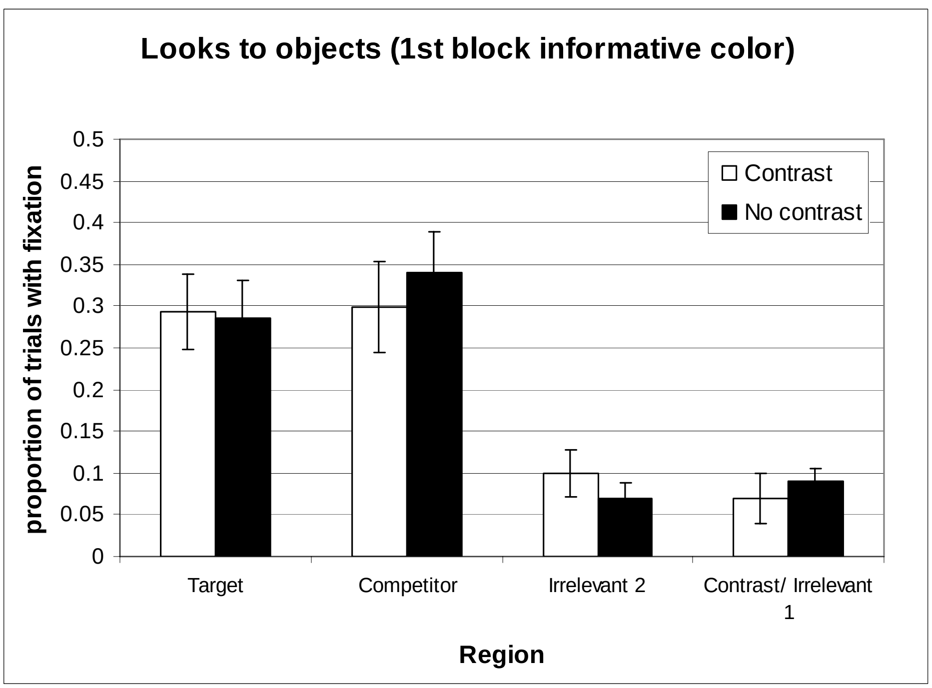

Figure D. Proportion of trials with a fixation to each of the four objects in the display for color modified instructions.

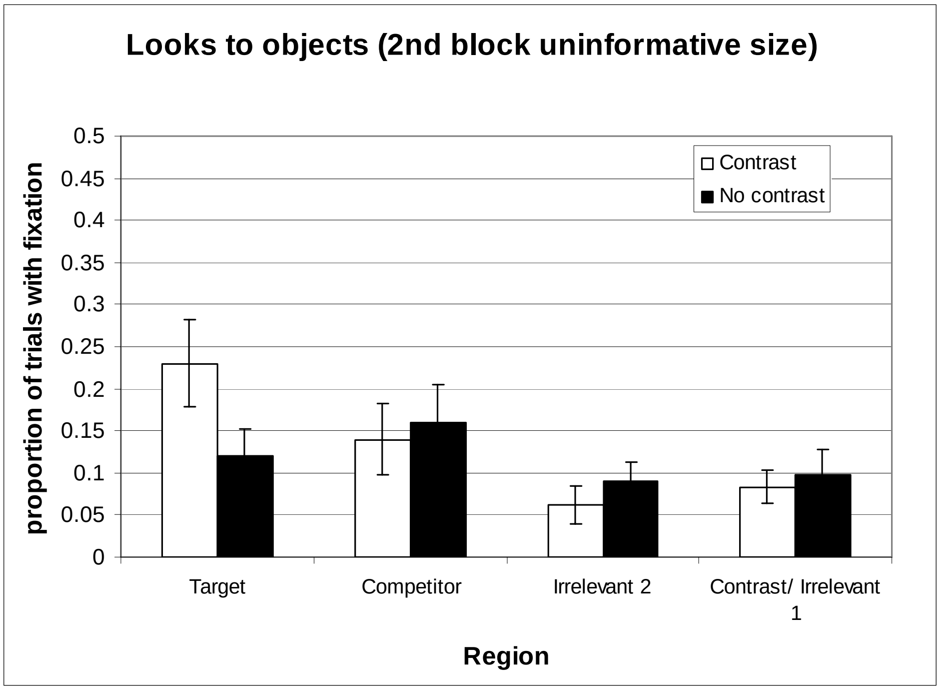

Figure E. Proportion of trials with a fixation to each of the four objects in the display for size modified instruction.

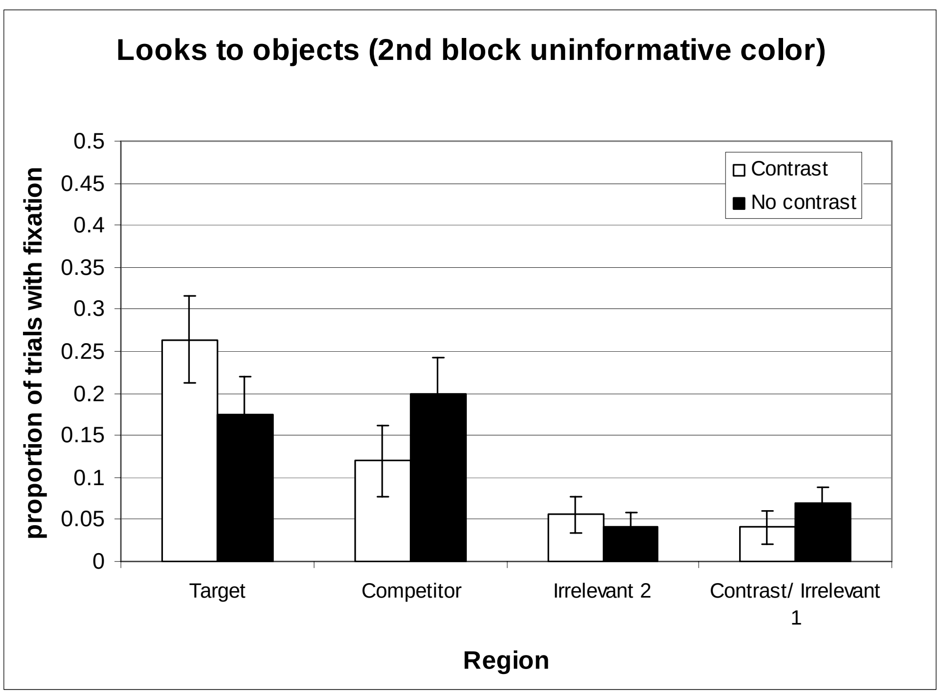

Figure F. Proportion of trials with a fixation to each of the four objects in the display for color modified instructions.

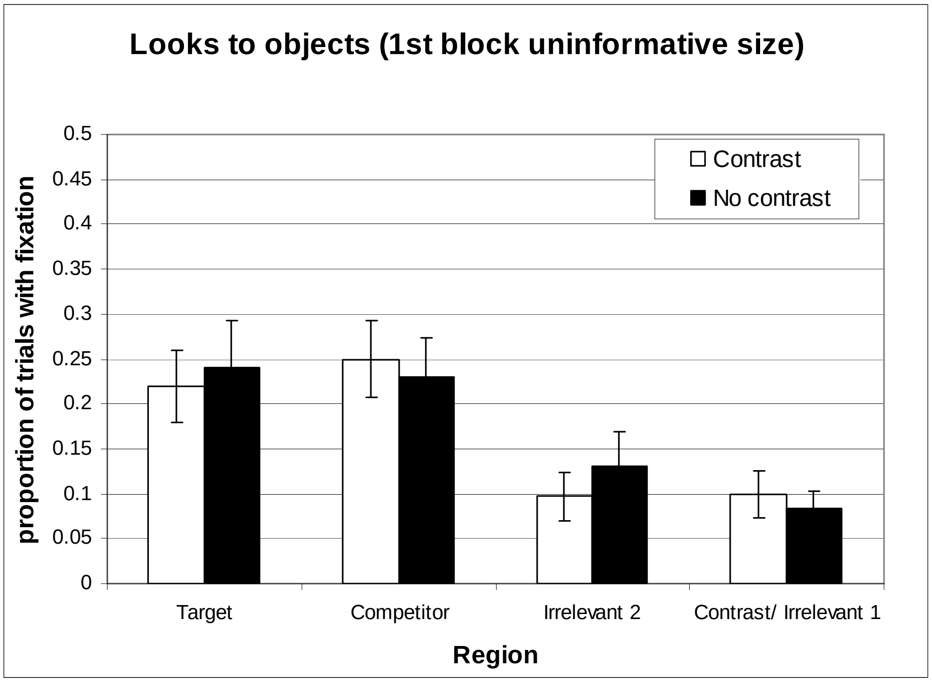

Figure G. Proportion of trials with a fixation to each of the four objects in the display for size modified instruction.

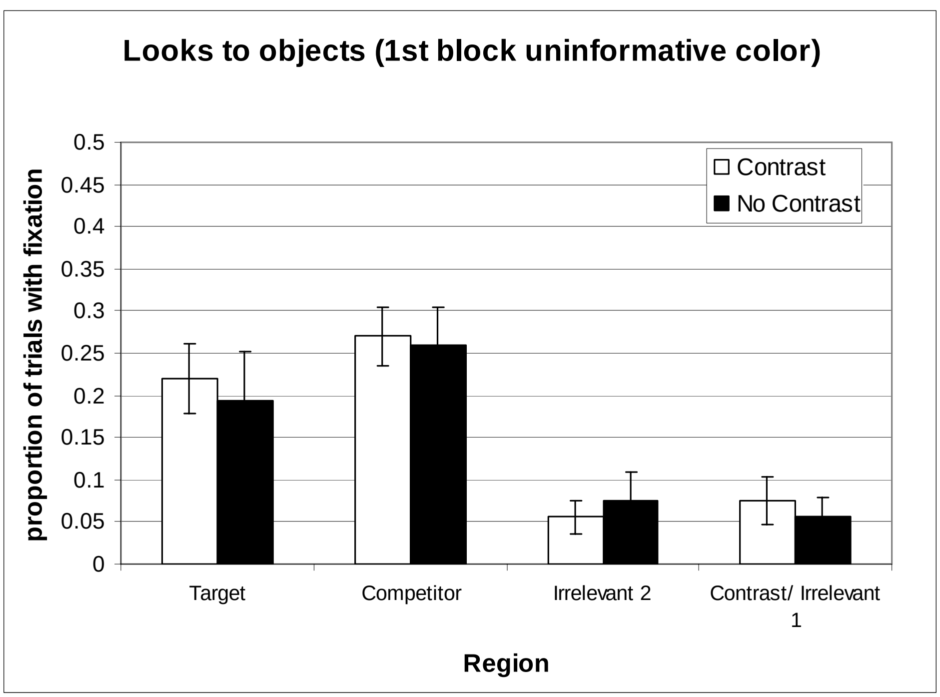

Figure H. Proportion of trials with a fixation to each of the four objects in the display for color modified instructions.

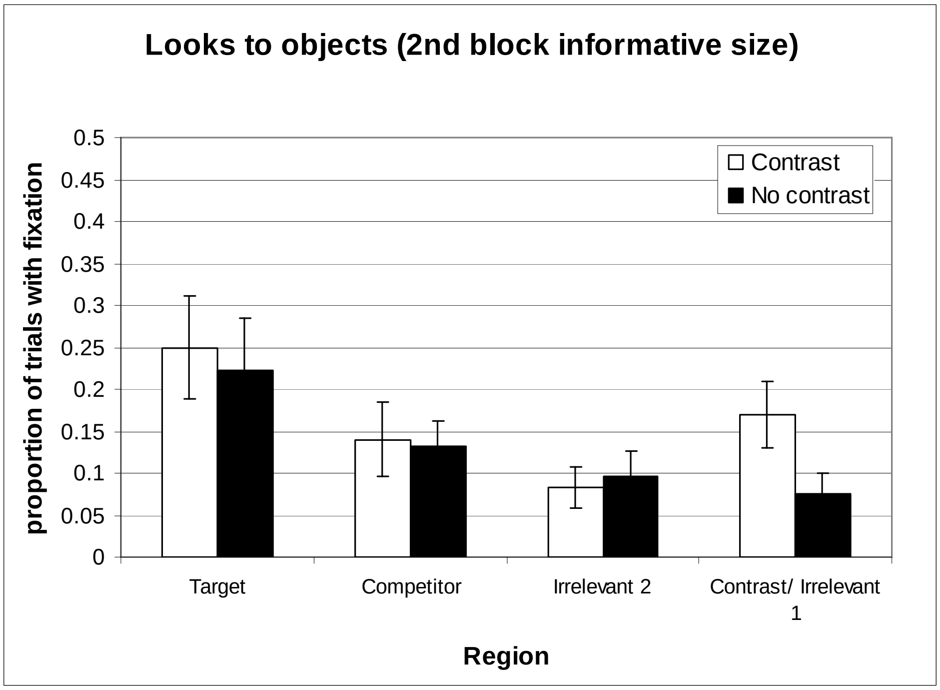

Figure I. Proportion of trials with a fixation to each of the four objects in the display for size modified instruction.

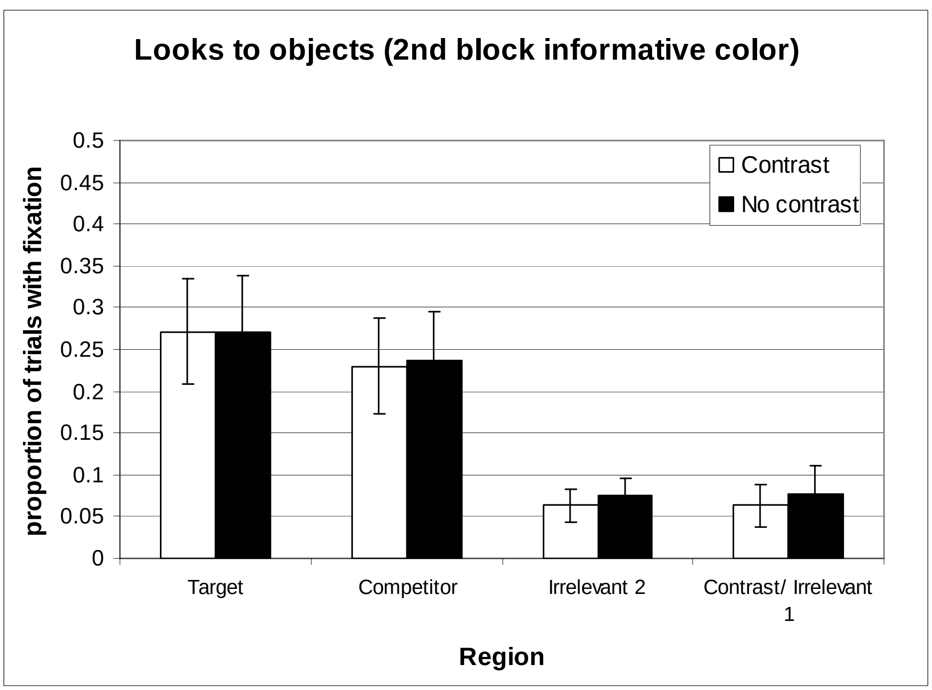

Figure J. Proportion of trials with a fixation to each of the four objects in the display for color modified instructions.

Appendix C

Figures K and L show the looks to each of the four objects in the display during the modifier for Experiment 3. The main thing to note is that the pattern of looks for the size modified instructions is similar to the previous experiments, except that the proportion of trials with a fixation to the target is lower for the size-contrast condition. However, there is still an advantage for the target compared to the competitor. There is also a trend of a target-advantage with the no contrast display. The results in Figure L are similar to the previous experiments and were as expected.

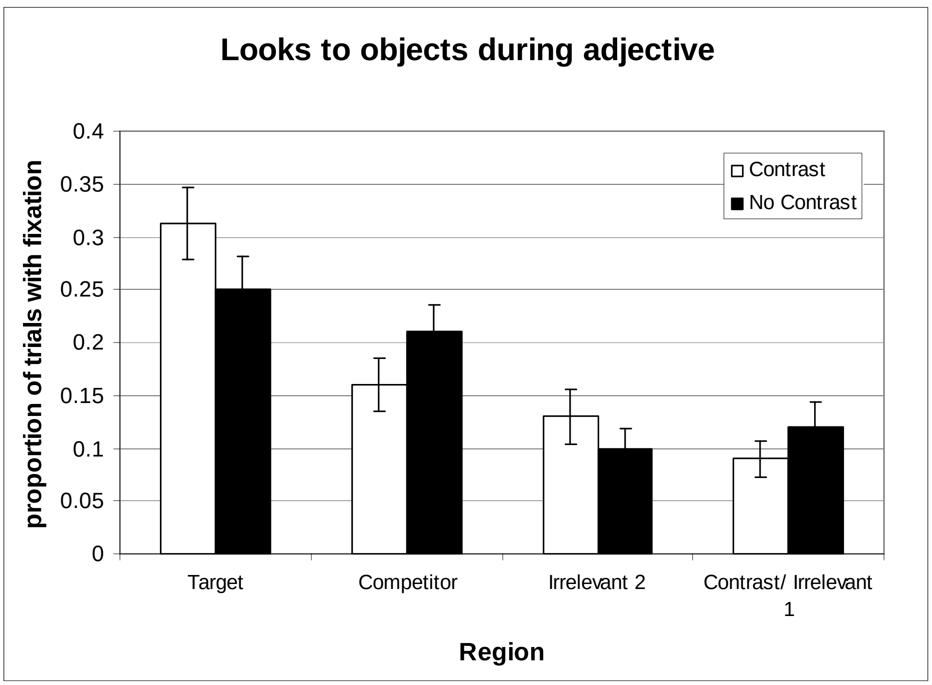

Figure K. Proportion of trials with a fixation to each of the four objects in the display for size modified instruction.

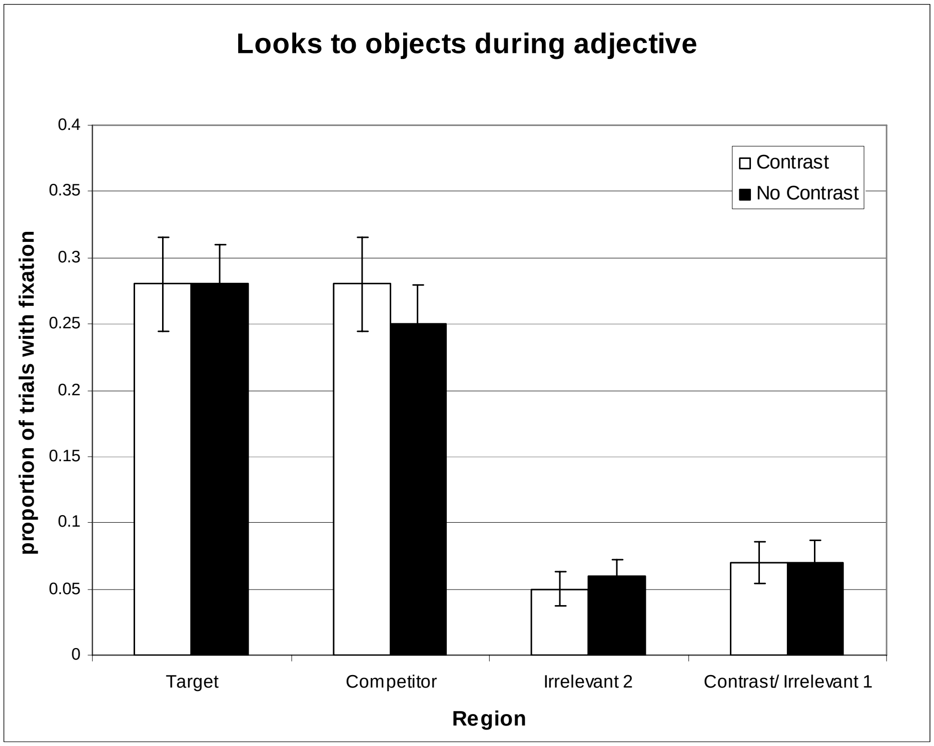

Figure L. Proportion of trials with a fixation to each of the four objects in the display for color modified instructions.