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Effects of salience and context on conceptual combination.

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EFFECTS OF SALIENCE AND CONTEXT ON CONCEPTUAL COMBINATION

A Thesis Presented

by

JEANNINE S. BOCK

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of the requirements for the degree of

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EFFECTS OF SALIENCE AND CONTEXT ON CONCEPTUAL COMBINATION

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CHAPTER 1

INTRODUCTION

The literature on conceptual combination discusses certain basic goals of the process: to expand a vocabulary to include novel terms (Downing, 1977; Wisniewski, 1996; Wisniewski & Gentner, 1991; Gerrig & Murphy, 1992); to further specify or subcategorize items which may already exist in a vocabulary, or to elucidate representations of items named by novel compounds (Wisniewski, 1997; Murphy, 1988); to specify referents of items in previous discourse (Gerrig & Murphy, 1992). Human beings are productive generators and interpreters of noun-noun (N-N) combinations. Such combinations do exist in natural language and are created, computed, and resolved successfully given sufficient and appropriate contexts. It is, therefore, important to define the factors which constrain the construction and successful interpretation of such combinations.

Perhaps one of the most plausible generalizations which applies to all reasons for creating combinations, and which pervades cognitive psychology, is economy. Conceptual combinations allow one to specify a concept without having to use more grammatically complex constructions such as relative clauses, prepositional phrases, or complex noun phrases. The use of N-N combinations allows a speaker to communicate the most relevant information about an item in the most economical fashion. Different contexts also have an effect on how combinations are interpreted and what aspects of those interpretations are carried over to later combinations in the same discourse. The current investigations of conceptual combination examined three primary questions: which features of certain concepts are critical in combinations, what strategies are used
when interpreting combinations, and what information about a particular construction is carried through a discourse.

There are a number of factors which constrain how N-N combinations are constructed and interpreted. The simplest constraint is word order. In general, the first noun in a combination (N1) acts as the modifier of the second, or head, noun (N2). Given that the modifier is generally the first noun in a combination, N-N combinations are constrained by the constituent nouns themselves; often some aspect of the modifier serves to specify a particular instance of the head.

N-N combinations are further constrained by the specification which a speaker intends to highlight. The salience of a selected modifying attribute may drive the interpretation of a combination by further specifying members of a category or subcategory. By using conceptual combination to identify new instances of category members, one can draw attention to the distinguishing features or characteristics which set that item apart from similar items and which therefore drive the construction of the combination. Such a salient attribute may map to an appropriate slot in the head noun, allowing that particular item to be distinguished from other members of the same category. For instance a tiger mouse is not an animal entirely distinct from other mice; rather it is a specific type of mouse, one of the set [mice] which is likely to be distinguished by the salient characteristic stripes. The entity specified by the resultant combination then will retain commonalities with the head noun but will also possess some aspect delineated by the presence of the modifier, an aspect which sets the combination apart from previously extant instances of the category denoted by the head noun alone (Wisniewski, 1997).
Conceptual combinations also provide economy of anaphoric reference in discourse contexts. By using a conceptual combination to denote a particular entity, a speaker may specify a referent which appeared previously in a discourse context without having to describe that referent with more complex constructions. In a passage about mice in which a striped mouse is mentioned, if the reader encounters the combination ‘tiger mouse’ later in the passage then the reader may easily understand the referent to be the striped mouse discussed earlier and therefore may not require more elaborate descriptions of that mouse. Becoming committed to such an interpretation of one N-N compound, however, might interfere with the later interpretation of similar combinations that require the use of a different dimension to construct the interpretation. In such cases, the economy of reference may actually work against a reader in that the method of least effort will lead them initially to the wrong interpretation.

Models of Conceptual Combination

Models of conceptual combination offer differing accounts of the construction and interpretation of N-N combinations. These models vary as to the emphasis they place on certain variables that potentially constrain such a process. The Attribute Inheritance Model (Hampton, 1987) claims that a combination inherits attributes from one or both of its parent concepts. Though this inheritance is sometimes the case in simple combinations which allow for modification of the head noun by the first noun, myriad other combinations exist which require elaboration of such parent attributes. The Selective Modification Model (Smith, Osherson, Rips & Keane, 1988) proposes that each constituent concept has certain slots which take appropriate fillers. This model claims
that the appropriate filler will be selected from the modifier and applied to the slot in the head concept. The Concept Specialization Model (Murphy, 1988; 1990) operates on much the same assumption as the Selective Modification Model but attempts to account for the importance of world knowledge in conceptual combinations by allowing for augmentation of a filler after an appropriate slot has been selected.

Glucksberg, McGlone, and Manfredi (1997) in an account of metaphor comprehension, note that while properties of a vehicle (Y) are attributed to a topic (X), the relevance of such attributes is determined by the dimensions along which the items can differ. This model has been extended to the realm of conceptual combination and, for the sake of this discussion, vehicle and topic are equivalent to the modifier and head noun, respectively. While the properties attributed to (X) generally are those epitomized by (Y), both constituents provide constraints on how a metaphor or conceptual combination can be interpreted. For instance, the appropriateness of particular dimensions on the head noun may also affect property attribution. Salient features from modifiers may be applied more successfully when they are paired with head nouns which have highly relevant dimensions (Glucksberg, McGlone, & Manfredi, 1997; Estes & Glucksberg, in press). Finally, the Structural Alignment view (Markman & Gentner, 1993; Gentner, 1993; Gentner & Markman, 1994; Wisniewski, 1996; 1997a; 1997b) also notes that the component nouns of N-N combinations are compared along relevant dimensions. This view, however, argues that the relevant process is one of matching alignable similarities and differences and choosing the appropriate attributes on the basis of similarity comparisons.
While slot filling may be a reasonable default, many N-N combinations do not follow a simple modifier to head slot-filling pattern and these combinations, too, must be accounted for. As much of the literature acknowledges, adjective-noun (A-N) combinations can obey a simpler modifier-head relation than can many N-N combinations. This may well be a result of the fact that, while adjectives can act as simple fillers for slots in a head noun (red filling the “color” slot of apple), nouns do not enjoy such a clear relationship when filling the role of modifiers. Nouns usually fill the role of heads. It may be more difficult to determine which property of a modifying noun is the appropriate attribute to fill the slot in another (head) noun. Furthermore, certain head nouns may provide a high level of constraint which guides the selection of relevant attribute dimensions. As noted by Murphy (1988; 1990) the constraint of world knowledge quickly comes into play in determining which fillers may be appropriate for which slots. For instance, if there is an extreme implausibility in one interpretation of a combination which is brought to light by information contained in the slot then one must search for another interpretation which avoids such implausibility. For example, a robin termite is unlikely to eat robins, rather it may be a red-breasted termite or a termite that eats robins’ nests (Wisniewski, 1996).

Strategies of Conceptual Combination

Property Mapping and Relation Linking

Along with the debate about how appropriate attributes are initially selected comes a debate as to the strategies used in conceptual combination. Two such strategies have come to be known as property mapping and relation linking (Markman &
Wisniewski, 1997; Wisniewski 1996, 1997a, 1997b, 1998; Wisniewski & Gentner, 1991). In property mapping, a property or attribute of the modifying noun maps to the head noun so a *robin termite* is interpreted as a termite with a red underbelly. In relation linking, some relation between the two nouns is posited so a *robin termite* is interpreted as a termite that eats robins or robins’ nests (Wisniewski, 1996).

Wisniewski & Gentner (1991) noted that if there was an attribute which was easy to map to the head noun, they observed more property mapping. If there is no such easily mapped filler, the authors argue that the tendency is to resort to relational interpretations. If, in a combination, there are descriptive properties which readily map (via structural alignment or some such comparison procedure) from one constituent to the second (optimally modifier to head) then attribute property mapping may well be the preferred strategy used in deriving the interpretation. If, however, there is no descriptive property to be so easily mapped, then the reader might well consult more of the relational properties to posit a plausible relation between the two nouns. Single attributes or fillers may behave much like adjectives, allowing for the default modifier-head relation to be followed as in A-N combinations. However, when those single attributes are not present or do not map easily then the combinatorial strategy must rely on a more elaborated relationship between the modifier and the head noun: a relation linking interpretation. The Role of Similarity

Numerous studies also have attempted to delineate the role which similarity plays in conceptual combination (Gentner & Markman, 1994, Markman & Wisniewski, 1997, Wisniewski & Gentner, 1991). Structural alignment (Markman & Gentner, 1991, 1993) states that the two constituent nouns of a N-N combination are aligned and compared
with one another in order to highlight relevant features and dimensions to attend to in similarity comparisons. Such alignment procedures lead to commonalities, alignable and non-alignable differences. According to this view, similar pairs generally have easily alignable structures, share many commonalities and alignable differences, and should encourage property mapping interpretations. Dissimilar pairs have structures which are not aligned easily, have more non-alignable differences, and are less amenable to property mapping interpretations. Markman and Gentner (1993) found that subjects listed more commonalities and alignable differences for similar pairs than for dissimilar pairs. Furthermore, they claim that alignable differences facilitate property mapping and that therefore the more similar the word pair, the easier it is to produce a property mapping interpretation because these pairs share alignable structures which allow the appropriate attributes to be selected; the more dissimilar the word pair, the more difficult it is to produce such an interpretation, therefore leading to the construction of a relation linking interpretation.

Wisniewski (1996) and Markman & Wisniewski (1997) noted that the more similar the word pair is, the more likely people are to map a single property to the head noun whereas with more distant pairs, more relation linking interpretations are posited. While Wisniewski (1996) did show the desired pattern in that pairs which were rated as being more similar showed a greater percentage of property mapping interpretations, there are some problems with assuming that this pattern is to be attributed solely to the level of assessed similarity. Wisniewski divided his stimuli into natural kinds, artifacts, and substances. He then had subjects rate the word pairs for similarity. A separate group of subjects was asked to interpret the combinations. These interpretations were then
scored for the amount of property mapping and relation linking in the interpretations.

One possible difficulty with Wisniewski's assessment of similarity was the fact that he sometimes crossed ontological categories to create his dissimilar pairs. Similar pairs were artifact-artifact or animal-animal, whereas dissimilar pairs sometimes were artifact-animal or animal-artifact. This ontological distinction may have led to his highest dissimilar ratings. There is enough evidence that artifacts and natural kinds behave differently that it seems to be a confound to construct word pairs by crossing such ontological categories. A more appropriate measure of the effect of similarity, if one were to stay with this method of rating, would be to construct word pairs which range in similarity while remaining within ontological categories so that the list would contain both high and low similarity animal-animal and artifact-artifact pairs.

The Role of Salience

As was stated previously, one reason for creating a N-N combination may be that there is a need to set the instance denoted by the combination apart from other instances included in the set of the head category. Given that conceptual combinations are driven by the selection of appropriate dimensions along which to construct a comparison, the need to set the instance apart is often exemplified by the modifier chosen. The entity named by the combination then remains a member of the category denoted by N2 but it is set apart within that category by the attributes highlighted by the choice of N1 as a modifier. The salience of particular attributes of one of the constituents may play a role in the interpretation of N-N combinations. Salient attributes in this case are attributes which stand out when a noun is rated out of context. For instance, a highly salient feature of the noun tiger is the attribute stripes. If one constituent in a N-N combination has a
particularly high salience attribute then readers may attempt to use the information conveyed by this attribute to construct a property mapping interpretation. If the modifier has no highly salient features, or no features which map well between the two constituents, the reader may be more likely to begin the search for plausible relations.

While Wisniewski’s investigations concentrated primarily on similarity comparisons, salience is also a factor with the potential to drive interpretations. There remain, however, a number of questions which revolve around which features are salient, as well as if and how such features remain salient in combinations. In the simplest case the question is one of whether, if there is a high salience feature on N1, that feature is likely to provide the basis for an interpretation of the combination. For instance, is a tiger-x generally an x with stripes? If this is the preferred strategy, then the question becomes one of which factors will influence the adoption of another strategy. If there are no high salience features on N1 it may be that the default strategy is to resort to more relation linking interpretations.

A related question is one of whether or not the salience of a particular feature on the head noun (N2) might have an effect on produced interpretations of N-N combinations. In most cases, N1 should dominate the combination as the role of N1 is generally to serve as modifier. However, if there is an extremely high salience feature on N2, this feature may somehow override the preferred modifier-head relation. Glucksberg and colleagues (Glucksberg, McGlone, & Manfredi, 1997; Estes & Glucksberg, in press) have noted that if there is a dimension on a head noun which is highly relevant to a particular salient feature of the modifier, more attribute property mapping interpretations are observed. In these studies the relevant aspect is the relevance of the dimensions on
the head noun rather than particularly salient features on the head noun. In the current investigations, dimension relevance was not controlled. Rather the investigation was concerned with the role of simple feature salience regardless of head dimension relevance. This is a conceptual distinction which is important for a full model of conceptual combination. The principal question, however, remains the same: will a highly salient feature or a highly constraining dimension of the head noun block some property mapping interpretations from being driven by features of the modifier?

One example which illustrates some of these questions is Wisniewski’s (1996) example *robin termite*. One salient feature of the modifier (N1), and perhaps of the combination, is the fact that robins have red breasts. Therefore one possible interpretation which would follow the conventional slot filling, or N1 as modifier, interpretation is that of a *robin termite* being a termite with some sort of red coloring, perhaps even a red underbelly (Wisniewski, 1996). However, there is also a highly salient property or dimension of the head (N2) which perhaps is more constraining. For the head noun *termite*, the property or dimension *eats wood* is extremely high salience. Therefore that attribute is another likely candidate for the basis of the combination and the resultant interpretation (a termite which eats something, namely robins) may not follow a simple modifier-head relation. *Robin* does not seem to be merely modifying *termite* in the manner in which *green* might modify *termite* in the A-N combination *green termite*. Rather *robin* seems to be filling some slot in *termite* (perhaps the slot *eats*) and the modifier then becomes that which is eaten rather than lending any of its particular attribute properties to the combination. However, it seems rather implausible to imagine a termite that gnaws upon robins. As a result, the reader may go one step further in
elaborating the interpretation of the combination to arrive at the relational interpretation “a termite that eats robins’ nests” (Wisniewski, 1997).

This elaboration illustrates the second exception which comes in to play in this combination. Not only is the combination not obeying a simple modifier-head relationship, the final interpretation is also heavily dependent on plausibility and world knowledge. The interpretation is constrained, at least hypothetically, by aspects of the words or concepts themselves. The salience of a feature (or a constraining dimension) of N2 has apparently overridden the simple modifier-head interpretation strategy. The salience of a robin’s red breast may not have been high enough relative to the salient constraint of a termite eating wood. An oak termite on the other hand might not be nearly as constrained. The combination still does not follow a direct property mapping interpretation (the termite probably does not resemble an oak tree, nor is it sturdy) but the relational interpretation (a termite that has a taste for oak trees) does not violate plausibility and therefore does not require further elaboration. An oak termite then, is a subcategory of termite, one distinguished by its particular taste for oak trees.

For the compound ostrich termite, however, the fact that an ostrich sticks its head in the sand may be higher salience, and more plausible in the combination, than the fact that robins have red breasts. This would allow ostrich to dominate the combination (adhering more closely to the general modifier head convention) resulting in termites which bury their heads in the sand or, in a more elaborated case, bury their heads in wood. If asked for further interpretations, readers might give the interpretation of termites who eat ostrich nests or ostrich eggs but these interpretations might not be as common because the feature sticks its head in the sand is highly salient and therefore may
be able to override the necessity to fill the slot eats or eats wood. In the case of robin termite, however, red may not have been as salient or constraining a feature of robin and with oak termite no such elaboration was necessary.

Similarly, Murphy (1990) asserts that in N-N compounds the modifier often will not have a single attribute which dominates the rest. He further demonstrates that, even if there is a highly salient feature included in the frame of the modifier, that feature does not necessarily map readily to the head. Murphy cites the example of an ocean bird. In this example, the salient features of ocean (e.g. made of water, salty) do not map to the head noun to create an interpretation of a watery or salty bird. Rather the interpretation is one of a bird that lives by the ocean. This example does argue against an account based on simple feature salience. Furthermore, it does demonstrate the need for plausibility constraining the interpretations of noun phrases and so adds to the difficulty of explaining conceptual combination constraints.

Effects of Context

Another factor which may affect the interpretation of novel N-N combinations is the constraint of previous context (Murphy, 1988, 1990; Gerrig & Murphy, 1992). If there is an interpretation of a combination that is exceptionally easy to arrive at out of context (e.g. the interpretation of a tiger mouse as a mouse with stripes), then that interpretation may play a role when the combination appears in a discourse context. Furthermore, context may play a role in the interpretation of conceptual combinations in that a combination presented in a discourse may involve a specific type of relationship between its two constituents. Gerrig and Murphy (1992) found that reading time on a
sentence following a combination was faster when the relation which provided the basis for the combination had been given explicitly in the preceding text than when the context provided no such relation. Similarly, the authors found that participants rated a compound as more comprehensible when the context passage contained another compound which shared the same relation than when the passage did not explicate such a relation (their "neutral" condition). In this case the term "relation" simply denotes a relationship between the two nouns. It is not necessarily a relation linking interpretation.

Gerrig and Murphy conclude that the understanding of novel compounds in context requires more than the simple search for a referent, rather it requires the formulation of a relation between the two nouns making up the combination.

Given the above results, if a reader arrives at an interpretation of a combination in context, such a decision may facilitate later interpretation of a second combination if that second combination has a relational structure parallel to the first. By interpreting the first combination and carrying this interpretation over, much of the reader's work, at least potentially, already is done. If, however, the second combination requires a different interpretation than the first (use of a non-parallel dimension), and this requirement is suggested by the following disambiguating material, then the interpretation carried over from the first combination may actually interfere with the processing of the second. As these effects are probably resolved quite quickly by context, on line reading studies seem an appropriate method for evaluating the time course of interpretation and ambiguity resolution of N-N combinations in context.
Current Investigations

The current investigations approached the issue of conceptual combination from two directions. In the first experiment, the salience of features of the modifier (N1) and head (N2) nouns was manipulated to investigate the varying contributions of salient properties to the interpretations of N-N combinations. Participants were asked to provide interpretations and similarity ratings for 160 N-N compounds with modifiers and heads of varying salience. These interpretations then were evaluated in terms of the use of property mapping and relation linking strategies and also in terms of any effect which salient features had on the interpretations given. The results are discussed in terms of ontological category, strategies used, and simple feature salience. The second experiment addressed the question of context effects. Combinations which produced two relatively balanced interpretations out of context were placed in contexts with preceding combinations to investigate the effect which the use of parallel and non-parallel dimensions would have on the interpretation of the second combinations. Participants read 16 experimental passages while their eye movements were recorded. Each passage contained two novel N-N combinations placed either in parallel or non-parallel disambiguation contexts. The results are discussed in terms of reading times on critical regions throughout the passages.
CHAPTER 2
SALIENCE NORMS

In order to select items for use in Experiment 1 it was necessary to determine the salience of various terms. A norming study was run on a list of words taken from Batting and Montague (1969). The complete list of words normed appears in Appendix A. The norming study contained 320 words, divided equally into natural kinds and artifacts. Participants were asked to read the words and to list any features that they found to be highly salient. Participants were allowed to list more than one feature if they felt it to be appropriate (e.g. a lemon is both yellow and sour). After listing the features, participants were asked to rate the salience of the feature listed on a 7 point Likert scale with 1 being low and 7 being high. Each participant rated 160 words. After an initial pilot study, participants also were cautioned against listing word associations rather than salient features (e.g. listing Mickey for the word mouse or tamer for the word lion).

Data were collected from 60 undergraduates at the University of Massachusetts who received academic course credit for their participation. All responses were tabulated in terms of features listed and salience ratings given. To select high salience items, any term for which a particular feature received a 5, 6, or 7 at least 12 times out of 30 possible responses (40%) was considered high salience (see Appendix B). Low salience items had no single highly salient features and tended to produce a number of distinct and unrelated features, most rated between 2 and 4. Any item which approached but did not quite reach the criterion for high salience was excluded from both lists as it was also not considered low enough to be low salience. Items for which respondents primarily defined the item
(e.g. a petunia is a flower) rather than listing any actual features of the item were considered to be low salience. A number of terms which produced two or three moderately salient features any of which would probably be higher salience were it not for the presence of these others were excluded from both the high and the low salience lists used to make the combinations for the first experiment. For example the noun limousine produced relatively high salience features such as length, elegance, and special occasions all of which are related attributes. No one of these attributes reached the criterion for high salience in and of themselves yet none were low enough to be considered low salience either and therefore all were eliminated from further study. Also eliminated from further study were any words for which it seemed that the majority of the respondents did not know the definition of the word.
CHAPTER 3
EXPERIMENT 1

One way to look at the effects of salience on conceptual combinations is to manipulate the degree of salience of both the heads and the modifiers in N-N combinations. It then is possible to examine interpretations given for the N-N combinations in terms of what strategies (property mapping or relation linking) were used in generating the produced interpretations and, in turn, what effect salient features had on the strategies chosen. In Wisniewski’s (1996) similarity manipulation the word pairs which were used sometimes crossed ontological categories, thus resulting in natural kind-artifact pairs which in turn were rated as the most dissimilar pairs. To avoid such a potential confound, the word pairs in the present study were constructed with the restriction that both constituents be from the same ontological category (natural kind-natural kind or artifact-artifact). The relevant manipulation, then, was the degree of salience of the head and modifier nouns. Within both artifacts and natural kinds, N-N combinations were constructed which followed one of four patterns: both constituents were high salience (H-H), both low salience (L-L), modifier low and head high (L-H), or modifier high and head low (H-L). The full list of combinations appears in Appendix C.

Predictions

Natural Kinds vs. Artifacts

Property mapping and relation linking were expected to play different roles depending on whether the pairs were natural kinds or artifacts. Based on previous findings, and on experimenter intuition about the way in which animals and plants are
often named, natural kinds were expected to show more property mapping overall. The greater proportion of property mapping for natural kinds was expected, in part, because lexicalized natural kind pairs often pick out some descriptive attribute of the item being described (e.g. swordfish, zebra finch, spider plant) and this attribute, then, provides the item with a descriptive name, often based on appearance. As property mapping involves such attributes, more property mapping was expected for natural kind pairs.

Conversely, artifacts were expected to show more relation linking. Artifacts are, by their very nature, relational entities. They are defined by their function. While there may be salient attributes listed for artifacts (a knife is sharp; sandpaper is rough), these attributes often are inextricably related to the function of the item (knives being sharp allows them to cut; sandpaper being rough allows it to smooth). Therefore it was expected that artifact combinations would center on function and therefore would result in more relation linking interpretations. Within each ontological category, H-L pairs were expected to show the most property mapping followed by H-H, L-H, and L-L respectively. Specific reasons for the ordering of these expectations are given below.

The effect of modifier salience on the proportion of property mapping interpretations given was expected to be greater for artifacts than for natural kinds because of the base tendency for there to be more property mapping interpretations for natural kinds, with a resulting ceiling effect. Therefore, though facilitation of property mapping based on salience was expected in both ontological categories, the split between H-L/H-H and L-H/L-L pairs was expected to be greater for artifacts than the same split in natural kinds.
Salience

In general, if a high salience feature was present on the modifier noun (H-H, H-L), this salient feature was expected to drive the interpretation of the combination. This was expected because of the assumption that the high salience attribute will often be that attribute which distinguishes the particular example from other members of its head category or its class, thereby providing a reason for the construction of the combination. If, however, the head noun had a more constraining high salience feature (H-H, L-H) even if the modifier were high salience, it was expected that the interpretations produced would involve more relation linking or switching errors where switching errors are defined as interpretations in which a salient property of the head noun was mapped to the modifier noun thus violating the standard modifier-head relationship. Combinations with no highly salient features on either the modifier or the head (L-L) were expected to show the most relation linking as they would be the least likely to have a property which would drive a property mapping interpretation. The specific predictions for the four groups of salience pairings follow.

H-L: For the H-L pairs, the hypotheses were the most straightforward. If there was a high salience feature on the modifier noun, that feature was expected to drive the interpretation of the combination (provided a plausible interpretation was possible based on this feature). For instance, for the word robin, one highly salient feature is the bird’s red breast. Therefore, it was assumed that if robin was paired with a low salience head, the feature of the red breast might well drive the interpretation (e.g. a robin lark being a lark with a red breast).
H-H: Though the predictions for H-L pairs seem relatively straightforward, problems arise when there is a feature on the head noun which has equivalent or higher salience than the feature on the modifier noun. For instance, the fact that termites eat wood may be a property of equal or higher salience than the robin’s red breast in the combination robin termite. In that case, the highly salient feature on the head may make it more difficult to arrive at an interpretation which follows the basic modifier-head relationship. Subjects may opt for one of a number of options in this case. One possibility is that they may produce a relation linking interpretation (a termite which eats robins). Plausibility may also play a role, leading to even more elaborated interpretations. For instance, Wisniewski (1996) suggests that this combination may actually be interpreted as a termite which eats robins’ nests. Another possibility is that subjects might make a switching error, using the highly salient feature of the head noun to drive the interpretation (a robin that eats wood) thus violating the modifier-head relationship. Finally, H-H pairs were expected to show the most hybridization, taking properties of each noun and applying them so that a canary robin becomes a bird which is both a canary and a robin, perhaps both yellow and red (Wisniewski, 1996).

L-H: For L-H pairs, it was assumed that relation linking would be more prevalent than property mapping as there are no highly salient features to map from the modifier concept to the head concept. Therefore, in cases such as lark zebra, a relation linking interpretation might be encouraged (a zebra that eats larks or a zebra with larks riding on its back) as lark does not lend any high salience features to drive the interpretation. However, the salience of the feature on the head noun might again drive some of the interpretations as in the H-H pairs. N2 salience may produce switching errors (a lark
zebra being a striped lark) especially if plausibility is also a factor (larks are not likely to be eaten by zebras).

**L-L:** Pairs with no salient features on either constituent were expected to show the greatest proportion of relation linking interpretations, though not necessarily greater than the L-H pairs as those pairs also did not have salient features to map from the modifier. As in the L-H pairs, without any salient properties to drive property mapping interpretations, participants were expected to switch to a relation linking strategy in order to find some reason to justify the construction of the combination. Property mapping was still expected to some degree in both the L-H and the L-L pairs, but the properties chosen were expected to be more variable than in interpretations with highly salient features. L-L pairs were not expected to show switching errors as there are no high salience features on N2 to drive such errors.

**Similarity**

In terms of similarity, it was assumed that Wisniewski’s general finding would be borne out in that more similar pairs would encourage simple property mapping more easily than would dissimilar pairs. Therefore, an overall positive correlation of property mapping with similarity was expected. However, by restricting the pairs to within ontological categories, the pairs in the current study were expected to be less dissimilar than those in Wisniewski’s studies. Further, it seems that artifacts, by their very nature, encourage more relation linking interpretations than do natural kinds. It seemed relevant, then, to look correlations with similarity within this domain to see if very similar artifact pairs could indeed encourage more property mapping than do artifacts overall.
Method

Participants

Participants were 60 undergraduates at the University of Massachusetts who received academic credit for their participation. None of the participants had taken part in the salience norming study.

Procedure

Participants were presented with lists of 40 combinations and were asked to write down the interpretation which they thought best fit each combination. The complete list of noun pairs in Appendix C. A sample packet of materials appears in Appendix D. Participants were given the opportunity to list a second interpretation as well. This option was given with the rationale in mind that if a first interpretation relied on property mapping, a second interpretation might rely more on relation linking. After interpreting the 40 combinations, participants were then asked to rate a second set of 40 combinations (those which had been interpreted by a separate group of participants) for similarity. Therefore up to 15 sets of interpretations and similarity ratings were obtained for each of the combinations.

Finally, because certain words were excluded from the original salience norms due to experimenter error and were considered relevant to Experiment 2, participants were asked to list features and rate their respective salience for 10 additional words (see Appendix D). The procedure for this task was the same as that used in the original salience norming study.
Materials

The final lists from which the combinations were drawn consisted of 20 words from each of eight categories (High/Low Salience; Artifacts/Natural Kinds). Word pairs were constructed by taking randomly ordered lists from the separate groups and pairing them to create the combinations. Word pairs which were judged to be lexicalized or to be the close equivalent of a lexicalized term were eliminated from the final lists and were replaced by additional randomly generated pairs. The result was 20 combinations in each of the eight groups (see Appendix C for complete lists) for a total of 160 combinations. The combinations were then split into four lists of 40 combinations apiece (5 from each group). Also included were 10 noun-noun combinations which were thought by the experimenter to have a highly preferred interpretation out of context. These pairs were relevant for the construction of materials for the Experiment 2 and were included in order to check the experimenter’s intuitions as to their preferred interpretations.

All interpretations were tabulated and the responses then were evaluated in terms of the strategy used to produce the interpretation and any effect salient features had on the interpretation. Responses were scored as property mapping, relation linking, hybrid, switching error or "unscorable". Interpretations which took a specific attribute from the modifier and applied this attribute to the head noun were scored as property mapping (e.g. a robin termite being a red-breasted termite). Interpretations which posited a relation between the two nouns were scored as relation linking (e.g. a robin termite being a termite which eats robins or robins' nests). Responses which took their features from both constituents, and which resulted in an interpretation which was a combination of both constituents were classified as hybrids (e.g. a robin termite being a creature which is
both a robin and a termite). Interpretations which applied a feature of the head noun to the modifier noun, thus violating the modifier-head relationship were classified as switching errors (e.g. a robin termite being a robin which eats wood). Finally, any interpretations which merely defined one constituent (e.g. “bird”; “bug”), or which simply listed an attribute of one or the other without describing the role in the combination (e.g. “red”; “eats”) were coded as “unscorable”. The rationale for this was that it was unclear whether these participants were applying the property to the combination rather than just describing one constituent. This tendency did appear fairly often and seemed to be consistent by subjects in that certain participants tended to do this consistently, indicating that they were not really performing the required task. Also coded as “unscorable” were any anomalous interpretations and blank responses. These responses were left in to avoid biasing the data to appear as though only property mapping or relation linking interpretations occurred. Finally, when an interpretation was judged to be derived via property mapping, the effect of any salient features was scored to see if those features were driving the interpretation.

A subset of the interpretations (38%) were scored by a second interpreter using the above definitions. Initial inter-rater agreement was 94% and all differences were resolved by discussion.
Results

As the primary concern in this experiment was consistency of interpretation due to the manipulation of salient properties within items, the responses were tabulated by items and the following results are from ANOVAs run only with items as the random variable. The full set of results appears in Table 1.

Table 1. Proportions of Response Types Given

<table>
<thead>
<tr>
<th></th>
<th>Natural Kinds</th>
<th>Artifacts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HH</td>
<td>HL</td>
</tr>
<tr>
<td>Property Mapping</td>
<td>.50</td>
<td>.46</td>
</tr>
<tr>
<td>Relation Linking</td>
<td>.14</td>
<td>.20</td>
</tr>
<tr>
<td>Hybrid</td>
<td>.01</td>
<td>.00</td>
</tr>
<tr>
<td>Switching Errors</td>
<td>.12</td>
<td>.09</td>
</tr>
<tr>
<td>Unscorable</td>
<td>.23</td>
<td>.25</td>
</tr>
</tbody>
</table>

Natural Kinds vs. Artifacts

Figure 1 depicts the proportion of property mapping interpretations given in all 8 groups. As expected, natural kinds produced significantly more property mapping interpretations than did artifacts (42% vs. 27%; F(1,149) = 25.479, p < .001). Likewise, artifacts produced more relation linking interpretations than did natural kinds (35% vs. 18%; F(1,149) = 35.921; p < .001). The proportion of property mapping for natural kinds never exceeded 50%. A greater proportion of property mapping interpretations was expected but this number is explained, in great part, by the fact that the “unscorable” interpretations, which included blank responses and anomalous responses, were included in these analyses. Without such responses included, proportions would be much higher.
These results lead to the conclusion that, when N-N combinations are successfully interpreted, property mapping is the predominant strategy for natural kinds.

![Figure 1. Proportion of property mapping interpretations](image)

**Salience**

Overall, without dividing the groups into ontological categories, modifier salience produced the predicted effect. N-N pairs with high salience modifiers (HH, HL) produced more property mapping interpretations than those combinations with low salience modifiers (LH, LL) (40% vs. 29%; $F(1,149) = 12.04, p < .001$) and low salience modifiers produced more relation linking interpretations than did high (30% vs. 24%; $F(1,149) = 4.298, p < .05$) as was expected (see Figure 1). Within ontological categories, the split between proportion of property mapping interpretations for HH, HL and LH, LL combinations was expected to be greater for artifacts than for natural kinds because of a ceiling effect within the domain of natural kinds. This was not borne out. Natural kinds
did show significantly more property mappings for HH, HL pairs than for LH, LL pairs (49% vs. 31%; F(1,76) = 9.93, p < .002) but this was by no means a ceiling effect.

Again, this may be in part because “unscorable” responses were included. Furthermore, though artifacts were expected to show a greater increase in property mapping interpretations than were natural kinds (in the HH, HL vs. LH LL pairs) this difference was not significant for artifacts (30% vs. 24%; F(1,76) = 2.86, p = .10). Artifacts did not result in more property mapping interpretations for HH, HL vs. LH, LL pairs.

Figures 2 and 3 depict, respectively, the proportion of relation linking and “other” interpretations, pooling over salience of the head noun. “Other” in these analyses includes “unscorable” responses, hybrids, and switching errors. As predicted, artifacts did show significantly more relation linking interpretations for LL and LH pairs than for HH and HL pairs (39% vs. 31%; F(1,73) = 4.01, p = .05). Natural kinds, however, did not show the predicted difference (20% vs. 17%; F<1). Instead, natural kind LH and LL pairs produced significantly more "other" responses than did the HH and HL pairs (45% vs. 35%; F(1,76) = 7.02, p < .01) indicating that participants were either making switching errors or were failing to interpret the combination at all, giving either an anomalous response or no response. Natural kinds did not resort to a relation linking interpretation.
High salience N2s did lead to more switching errors than did low salience N2s (F(1,149) = 11.85, p < .001). This effect was stronger for artifacts than for natural kinds (interaction F (1,149) = 19.19, p < .05). Examples of switching errors produced by participants include the following: wasp mouse, a wasp that lives in the walls; carrot zebra, a striped carrot; scarf mirror, a reflective or silver scarf; pencil sandpaper, a gritty or rough pencil.

Figure 4 depicts the proportion of property mapping interpretations which were driven by a salient feature on the modifier. Overall, in combinations with high salience modifiers, the property mapping interpretations given were generally driven by the salient feature on the modifier noun. For natural kinds, interpretations were more likely to be driven by the salient feature than were artifacts (79% vs. 58%; F(1,74) = 9.66, p < .01).

However, as Figure 4 depicts, only the AHL group is below 70%. This observation is supported by a nearly significant main effect of head salience (F(1,74) = 3.60, p = .06) and a marginally significant interaction of ontological category x head salience (F(1,74) = 3.02, p = .09). This effect of head salience was unexpected and
prompted post-hoc evaluation of the materials in the AHL group. Such evaluation revealed that certain items in the AHL group did not behave as expected. This seems to be either because features on the head were higher salience than the norms revealed them to be or because of constraints imposed by the head noun itself. One example is the combination knife carpet. In isolation the word carpet was rated as low salience because it did not produce one single feature which reached the criterion for high salience. When the combinations were constructed, however, carpet was combined randomly with knife. This random pairing lead to an implausibility in mapping the salient feature of the modifier (a knife is sharp) to a conflicting dimension of the head (a carpet is something which is generally soft or plush, though neither were high salience in isolation). This implausibility may have blocked the potential property mapping interpretation based on the salient modifier feature (e.g. a sharp carpet).

Finally, though more hybrids were expected in HH pairs, these responses were extremely rare and as a result no analyses were run on the proportion of hybrid responses.

![Proportion Salience](image)

**Figure 4.** Proportion of property mapping interpretations driven by salient properties
Similarity

The expected replication of Wisniewski’s similarity correlation was not borne out. There was no correlation between similarity and proportion of property mapping overall \( r = -.06 \). Furthermore, there was no correlation within either natural kinds \( r = -.06 \) or artifacts \( r = -.14 \) alone. Individual correlations within the 8 groups also failed to reach significance: NKHH \( r = -.11 \); NKHL \( r = .14 \); NKLH \( r = -.02 \); NKLL \( r = -.52 \); AHH \( r = -.01 \); AHL \( r = -.31 \); ALH \( r = .00 \); ALL \( r = .12 \). The most significant correlation \( r = -.52 \) is in the wrong direction though this was due in part to a single deviant score. Removal or one outlying score reduced the correlation to a non-significant \( r = -.37 \). An argument based on similarity would expect a strong positive correlation between proportion of property mapping and assessed similarity. This lack of replication may be due in part to the fact that the combinations in this study were constrained to be within ontological categories (there were no artifact/natural kind or natural kind/artifact pairs) and therefore were not as highly dissimilar as those in previous studies.

Finally, because hybrids accounted for so little of the data (see Table 1), no correlations were run between similarity and the production of hybrids.

Conclusions

The purpose of this experiment was to examine whether the ontological category of N-N combinations influences the strategy chosen for interpretation, what effects salient features have on the produced interpretation of conceptual combinations, and whether or not such effects are correlated with assessed similarity.
Varying the ontological category of the nouns led, as expected, to property mapping interpretations being more prevalent for natural kind pairs than for artifact pairs and conversely to relation linking interpretations being more prevalent for artifacts than for natural kinds. When property mapping was not the chosen strategy it was assumed that interpretations would revert to relation linking strategies. This was the case for artifacts but not for natural kinds.

The fact that artifacts did show the expected tendency toward relation linking interpretations may be due to the relative ease with which relations can be posited between artifacts. Salient properties of artifacts are generally those of their function or properties intricately related to that function. For instance, salient properties of the word knife are the fact that it cuts (function) and the fact that it is sharp (a property necessary for that function). Such functional attributes might well encourage relation linking interpretations and may, in fact, reduce the number of property mapping interpretations which might be based more on visual attributes.

The resort to relation linking interpretations was not as consistent for natural kinds. When property mapping interpretations were not chosen, natural kind pairs tended to produce more switching errors or “unscorable” interpretations. This suggests that in the absence of an appropriate or salient property to map from N1 to N2, readers may opt not to interpret the combination at all rather than to posit a relation between the two nouns.

Natural kind names generally distinguish members of their head class along visual attribute dimensions (yellow, large, spotted). These visual attributes are generally listed as the salient features of such items. This tendency may lead to the predominance of
property mapping interpretations within this ontological category as the salient characteristics lend themselves well to creating a viable property attributions. Property mapping interpretations may be based on salient characteristics as these characteristics provide the justification for the initial construction of the combination by exemplifying what quality set the particular instance off from the rest of its class. Artifacts, on the other hand, tend to vary along functional dimensions. These dimensions may lead to more relation linking interpretations. The relational nature of artifacts may be of more importance then their visual attributes.

If one reason for creating N-N combinations is to subcategorize or distinguish instances of a head noun, then it seems that using a strategy which allows one to arrive at a name which relies on a constant distinguishing feature will be the most appropriate approach to this process. To create such a name, the characteristics which remain constant may be those selected to drive the interpretation. Property mapping interpretations often select an attribute of the modifier constituent (e.g. yellow) and apply it to the interpretation in such a manner that the name can remain constant (a banana goose is a yellow goose and yellow is constant). Relation linking interpretations, on the other hand, often result in a more temporal description of the combination (a banana goose is a goose eating bananas but this is not necessarily a permanent characteristic of that goose). This may explain the predominance of property mapping as the interpretational strategy for natural kinds. Furthermore, it is conceivable that property mapping interpretations can incorporate secondary relational interpretations without conflict as property mapping can assert a name and relation linking can assert a tendency
or current state (a banana goose is a yellow goose which also happens to be eating bananas at this moment).

The manipulation of feature salience did have the expected influence on the interpretations produced. For both artifacts and natural kinds, when there was a high salience modifier, more property mapping was observed and for pairs with low salience modifiers more relation linking was observed. Furthermore, when property mapping interpretations were produced, the salient feature on the modifier was the predominant feature used in the generation of the interpretation. These results support the view that when salient features are present on the modifier those features are selected to drive the interpretation of a N-N combination. Such salient features may provide the needed justification for the creation of the combination in that they may be the features which distinguish a particular instance from the larger set denoted by its head. Furthermore, high salience N2's also played a role in the interpretations produced. More switching errors were made on N-N combinations with high salience features on N2. In these cases, the high salience feature on the head was important or salient enough to violate the standard modifier-head relationship.

Finally, one tendency which occasionally appeared in the data but which was not explicitly investigated in the current study was that salient features of N2 may have blocked certain interpretations because a high salience feature on N1 was not high enough salience to override that on N2. In the example robin termite, robin has the high salience attribute of being red-breasted. However, there is an aspect of the noun termite which requires some consideration of the fact that the creature eats things, generally wood. Therefore, one interpretation given numerous times was ‘a termite that eats robins’ or ‘a
termite that eats robins’ nests’ rather than ‘a red breasted termite’. In these cases, though there was a high salience feature on N1 which could provide an entirely plausible interpretation, there was a high salience feature on N2 which was more constraining.

This salient characteristic of N2 may not be an attribute so much as a highly constraining slot containing the relation eats. Estes and Glucksberg (in press) recently noted that property attribution was greater for combinations in which modifiers with salient features were paired with heads which had highly relevant dimensions than for combinations that had heads with low dimension relevance. Therefore the fact that a termite eats wood might not be a salient feature so much as a relevant dimension. The present assessment of salience does not allow for examination of this possibility but it seems a highly appropriate factor for further investigation. Murphy’s Concept Specialization Model (1988; 1990) also addresses the need for elaborated slot filling procedures based on world knowledge. In either case, the interpretations produced do emphasize the need for world knowledge and therefore argue for models which allow some level of elaboration or augmentation of slot filling.

Finally, if similarity were an essential factor in determining the proportion of property mapping interpretations, then there should have been a strong positive correlation between assessed similarity and the proportion of property mapping interpretations given. The fact that there were no correlations with similarity indicates that, though similarity may have been an important factor in previous studies, there are other factors which influence the strategies of conceptual combination that are chosen. The constraint of keeping the word pairs within ontological categories may have lessened the overall dissimilarity ratings in comparison to previous studies. The ratings in the
present study, however, did span a wide range of scores (1.3 - 6.5 on a 7 point scale) so it was not the case that all word pairs were rated as highly similar. Furthermore, Estes and Glucksberg (in press) observed an increase in property mapping based on salient features and relevant dimensions while holding similarity constant, providing complementary evidence for a lesser role of similarity.

This argument is not intended to entirely disavow the possible role of similarity. There is a great deal of research to support it. Rather, the current experiment suggests that other strategies may take precedence over similarity comparisons. One such strategy relies on the salience of particular features. Information about which features are likely candidates for the creation of a N-N combination may lead to a more economical strategy of interpretation than exhaustive similarity comparisons and alignment procedures. Use of salient features in creating N-N combinations may provide a more economical method than similarity comparisons as the use of such features can immediately draw attention to the distinguishing characteristics without having to extensively compare two constituents. However, in the absence of high salience features on either noun, alignment and comparison may remain a viable strategy. It may be that if pairs were constructed to be highly similar and highly dissimilar, more of an effect of similarity would be observed even within the current experiment. However, such a finding would not be generalizable to conceptual combination as a whole.

One way to further investigate the role of similarity might be to construct pairs of high-similarity artifacts which share very similar functions and visual forms. By having highly similar functions, the relational dimensions along which the combination could be distinguished from other members of its head might be lessened. As a result, visual
characteristics may become more salient than they generally tend to be for artifacts. These combinations, then, might produce more property mapping interpretations than are usually observed for artifact pairs.
CHAPTER 4
EXPERIMENT 2

Experiment 2 investigated the effects of context on the interpretation of N-N combinations. Gerrig and Murphy (1992) found that a second combination was rated more comprehensible if it was preceded by a combination which shared and explicitly delineated a relation which could be used in the interpretation of the second combination. For instance, having read a passage which included a trumpet olive being described as a trumpet carved out of an olive, readers then rated kitten apple (presumably a kitten carved out of an apple) as more comprehensible than if the combination trumpet olive had not appeared earlier in the passage.

The present experiment explored whether such a bias would have on-line consequences for reading. Numerous studies (Frazier & Rayner, 1982; Rayner & Duffy, 1987; Duffy, Morris & Rayner, 1988) have demonstrated that immediate selection of one syntactic analysis or one meaning of an ambiguous word can lead to disruption of reading on following disambiguating material. In treating novel N-N combinations which have more than one possible interpretation as ambiguous words, one can apply similar “garden path” logic. Readers may take the information used in interpreting one combination and try to apply a parallel interpretation immediately while reading a second combination, as was suggested by Gerrig and Murphy’s results. If readers do apply the same manner of interpretation to a second combination then one might expect that when the second combination does in fact use a dimension parallel to that used in the disambiguation of the first combination, the reader might successfully interpret the second combination.
based on that dimension. The reader may then read the disambiguating material with relative ease when compared to conditions in which the disambiguating material suggests an alternative interpretation of the second combination.

Design

Sixteen passages were constructed in which two N-N combinations were contained in the text. The second combination either shared an interpretation based on the same dimension as that used in the first combination (parallel dimension) or used introduced a new dimension which was not parallel to the first combination’s interpretation (new dimension). The question addressed was whether, if the first combination had a distinct interpretation confirmed by the context then would a second combination presented later in the passage be read faster when it used a parallel dimension than when it used a new dimension. For instance, if the first combination was leopard mouse and the second combination was tiger mouse then there is a shared dimension (that of pattern) which could provide a parallel interpretation for the two combinations. The leopard mouse could be disambiguated within the passage to be a mouse with spots. The tiger mouse then could be disambiguated along the same dimension while using a slightly different feature (e.g. a mouse with stripes). Alternatively, the disambiguation of the combination tiger mouse could introduce a new dimension for the interpretation of the second combination (e.g. a fierce mouse or a mouse that jumps through hoops at a circus). Following garden path logic, if the interpretations of the two combinations were based on a parallel dimension, reading was expected to proceed relatively normally through the disambiguating material. If the
second interpretation was disambiguated to use a new, non-parallel, dimension, more disruption was expected to occur in the disambiguating region after the second combination.

Sixteen combinations were selected from the lists used in Experiment 1 (see Appendix E). The 16 combinations selected each had two interpretations that were given consistently by the participants in Experiment 1. The two interpretations together always made up at least half of interpretations given. The 16 combinations were selected to be as balanced as possible, generally occurring with equal frequency overall. However, each combination had one interpretation which was generally given as the first interpretation and another interpretation which was generally given second. The interpretation given first was considered dominant and the secondary interpretation was considered non-dominant. Of all interpretations given (including all responses), the dominant meaning was given 29% of the time and the non-dominant meaning was given 22% of the time. Of the first interpretations (including only dominant and non-dominant responses) the dominant was given 63% of the time and the non-dominant was given 37% of the time. Of the second interpretations (again including only dominant and non-dominant responses) the dominant interpretation was given only 42% of the time and the non-dominant was given 58% of the time.

In all of the experimental passages, the second combination was one of the 16 selected combinations. The first combination in the passage was disambiguated to use a particular dimension for its interpretation. The second combination could be interpreted either by use of the same (parallel) dimension or by the use of a different (new) dimension. The intended interpretation of the second combination was disambiguated in
the sentence following the second combination’s presentation. This disambiguation either encouraged the use of a parallel dimension or required the introduction of a new dimension for resolution of the second combination. In half of the passages, the disambiguating material led to the dominant meaning of the second combination (or its relevant control). In the other half of the passages the disambiguating material led to the non-dominant interpretation.

Control conditions were constructed to demonstrate that any disruption effects were due to readers attempting to apply a parallel dimension interpretation to the second combination rather than an inconsistency in the context of the paragraph itself. For each experimental passage a control passage was constructed which contained a simplified version of the second combination. For instance, if the second combination in a passage were banana goose, the control might be that goose, or another goose. The control words used were “another” and “different”, with the exception of one passage in which the control word was “that”. If reading patterns in these control cases were the same as in the cases which contained a second combination then any effects could be due to context disruption alone rather than to a direct effect of conceptual combination resolution. However, if these control passages did not show disruption relative to the passages with the second combination, then disruption could be due to the shift of dimensions used in the interpretation of the two combinations.

There were, therefore, eight conditions. An example passage presented in all eight conditions appears in Table 2. The complete set of experimental passages appears in Appendix F. The first four passages used the dominant interpretation as the disambiguation of the second combination. The second four passages used the non-
dominant interpretation. Within each of these blocks there were four conditions. In the first condition (parallel dimension), the second combination’s disambiguation used a parallel dimension to that used in the first (e.g. a cardinal goose is red; a banana goose is yellow). In the second condition (parallel dimension control), the general context supported the parallel interpretation, but there was no second combination. Instead, the combination was replaced with a control phrase (e.g. a cardinal goose is red; that goose is yellow). In the third condition (new dimension), the second combination’s disambiguation required the use of a new dimension than that used for the interpretation of the first combination (e.g. a bread goose eats bread; a banana goose is yellow). The fourth condition (new dimension control) had a general context which biased for a non-shared relation but, as in the second condition, there was no second combination (e.g. a bread goose eats bread; that goose is yellow).

There were also 24 filler passages (see Appendix G) which contained either one or two lexicalized N-N compounds. All passages ranged in length from six to nine lines of text.
Table 2. Example Passage from Experiment 2

Condition 1: Dominant Interpretation/Parallel Dimension Disambiguation/Experimental
Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. "Look at this cardinal goose" said Timmy as a light read goose came up to him. "I prefer the banana goose" said Bill, pointing at a bright yellow goose sitting on a rock. Just then the geese took off and flew across the lake.

Condition 2: Dominant Interpretation/Parallel Dimension Disambiguation/Control
Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. "Look at this cardinal goose" said Timmy as a light read goose came up to him. "I prefer that goose" said Bill, pointing at a bright yellow goose sitting on a rock. Just then the geese took off and flew across the lake.

Condition 3: Dominant Interpretation/New Dimension Disambiguation/Experimental
Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. "Look at this bread goose" said Timmy, referring to a goose eating bread right out of his hand. "I prefer the banana goose" said Bill, pointing at a bright yellow goose sitting on a rock. Just then the geese took off and flew across the lake.

Condition 4: Dominant Interpretation/New Dimension Disambiguation/Control
Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. "Look at this bread goose" said Timmy, referring to a goose eating bread right out of his hand. "I prefer that goose" said Bill, pointing at a bright yellow goose sitting on a rock. Just then the geese took off and flew across the lake.

Condition 5: Non-Dominant Interpretation/Parallel Dimension Disambiguation/Experimental
Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. "Look at this bread goose" said Timmy, referring to a goose eating bread right out of his hand. "I prefer the banana goose" said Bill, pointing at a goose eating bananas from his hand. Just then the geese took off and flew across the lake.

Condition 6: Non-Dominant Interpretation/Parallel Dimension Disambiguation/Control
Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. "Look at this bread goose" said Timmy, referring to a goose eating bread right out of his hand. "I prefer this goose" said Bill, pointing at a goose eating bananas from his hand. Just then the geese took off and flew across the lake.

Condition 7: Non-Dominant Interpretation/New Dimension Disambiguation/Experimental
Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. "Look at this cardinal goose" said Timmy as a light read goose came up to him. "I prefer the banana goose" said Bill, pointing at a goose eating bananas from his hand. Just then the geese took off and flew across the lake.

Condition 8: Non-Dominant Interpretation/New Dimension Disambiguation/Control
Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. "Look at this cardinal goose" said Timmy as a light read goose came up to him. "I prefer this goose" said Bill, pointing at a goose eating bananas from his hand. Just then the geese took off and flew across the lake.
Method

Participants

Seventy-two undergraduate students at the University of Massachusetts were paid or received experimental credit for participation in the experiment. Of these 72 participants, 15 did not track successfully and therefore did not complete the experiment. 17 others completed the experiment but yielded data that was either unusable because of numerous track losses or because on three or more of the 16 experimental items the participants did not fixate all 4 critical regions in their first pass through the passage. Therefore, data from 40 participants, five in each condition, were included in the analyses. All participants were native English speakers who had either normal, uncorrected vision, or had vision corrected with the aid of soft contact lenses. All participants were naïve as to the manipulations within the study and none had participated in the salience norms or in Experiment 1.

Procedure

When a participant arrived for the experiment, a bite bar was prepared so that head movements could be minimized while the experiment was in progress. The eyetracker was calibrated for each participant individually. Calibration took approximately five minutes. A brief practice session followed calibration in order to familiarize the participant with the specific procedure of the experiment. Participants were told that the experiment involved the study of normal reading and that they were to read each passage at a normal speed but to read carefully and for comprehension as they would periodically be answering questions which appeared on the screen. Participants were told to read normally would and to feel free to reread the passage if necessary.
At the beginning of each trial, a fixation box appeared in the center of the screen and above that appeared a row of five boxes. The participant was instructed to look at the center of the screen and then to a box at the top center of the screen. The participant then fixated a series of boxes leading to the far left of the screen. When the participant’s eye was at the far left box, the experimenter presented the passage. Participants then read the passage. When they felt they had comprehended the passage, participants looked to a box presented just below the end of the passage and pressed a button to erase the passage. A comprehension question followed each trial. The question appeared on the screen and participants pressed a button when they had read the question. The answer choices then appeared on the screen and the participant pressed the appropriate response key according to whether the correct answer was on the left or the right hand side of the screen. Between trials, calibration of the eyetracking system was checked to ensure consistent data collection.

**Apparatus**

Eye movements were recorded by a Fourward Technologies Dual Purkinje Eyetracker which has a resolution of 10’ arc. The eyetracker was interfaced with an American Computer Innovations 486 computer which ran the experiment. Viewing was binocular, with eye location recorded from the right eye. The position of the participant’s eye was sampled every millisecond by the computer and averaged over four consecutive samples. The average horizontal and vertical positions of the eye were compared with those of the previous sample to determine whether the eye was fixed or was moving.

Passages were presented on a View Sonic 17G monitor, with up to 72 character spaces per line. During the experiment, the participant was seated 62 cm. from the
monitor, where four characters equal one degree of visual angle. The characters were presented in lower case except when upper case was called for (e.g. at the beginning of each sentence and for proper names). Luminance on the monitor was adjusted to a comfortable brightness level for the participant and then was held constant unless pupil contraction dictated a change in brightness. The room was dark except for an indirect light source that enabled the experimenter to keep notes during the experiment.

**Predicted Results**

Passages were segmented to include four critical regions (see Table 3):

C1 was the first combination; D1 was the first disambiguation; C2 was the second combination (or its control); D2 was the second disambiguation. It was predicted that first pass times on the second combination (C2) would be comparable regardless of condition as the effect of parallel vs. new dimension would not be evident at this point in the passage. In conditions 3 and 7 (Dominant/ and Non-Dominant/ New Dimension/ Experimental), where the disambiguation of the second combination required use of a non-parallel dimension, more disruption was expected in the disambiguating region after the second combination (D2) than in conditions 1 and 5 (Dominant/ and Non-Dominant/ Parallel Dimension/ Experimental conditions) where such disambiguation used a dimension parallel to that used in the first combination. Disruption was expected to show up in first pass and total reading times in D2, as well as in the probability of regressions out of D2. Regressions were predicted to go back to the second combination (C2) and possibly back to the first combination’s disambiguation (D1) as these regions provide information relevant to the interpretation of the second combination.
Assuming that there is some processing load associated with interpreting a N-N combination independent of disambiguation, first pass and total reading times on C2 were expected to be faster for the control conditions containing a phrase such as “another x” (2, 4, 6 & 8) than reading times in the same region when it contained a second combination (1, 3, 5 & 7). Furthermore, reading of the disambiguating material (D2) was expected to proceed with less disruption and the probability of regressions was expected to be less in the control conditions (2, 4, 6 & 8) than in the experimental conditions (1, 3, 5 & 7).

Results and Discussion

The data from Experiment 2 were analyzed in terms of first pass, total, and second pass reading times on four critical regions (see Table 3). A series of analyses were conducted ranging from full sentence raw reading times to ms/char reading times on particular regions. In light of the absence of significant effects in the initial analyses, a bias norming study was conducted and four items were identified as not producing the required bias within the passage. These four items were removed from the final analyses. These analyses of selected items receive the most attention in the following discussion as they deliver the clearest representation of the data. Furthermore, only results which were significant by both subjects and items or which are of specific hypothetical interest are discussed.

The data are presented in terms of three measures: first pass time (the sum of all fixation durations from first entering the region to first leaving it, ignoring trials on which the region was skipped); total time (sum of all time spent in region including time spent in region after regression from anywhere else in the text, ignoring trials on which the
region was skipped); second pass time (time spent in region after going past region to the right). Mean raw times are presented for the relevant measures. As word length was not equated across regions, the results are presented primarily in terms of ms/char, a measure which makes regions of different lengths roughly comparable for analysis and generally produces higher significance values and lower error variances. For each of the measures a series of 2 (dominant x non-dominant interpretation) x 2 (parallel x new dimension disambiguation) x 2 (experimental x control) ANOVAs were performed with subjects (F1) and items (F2) as random effects.

The primary analyses were performed by dividing each passage into 15 regions with four critical regions of interest. A sample passage follows in Table 3, with the regions separated by ( / ) and with the relevant regions numbered as they will be referred to for the remainder of the discussion. Again, C1 is the first combination; D1 is the first combination’s disambiguation; C2 is the second combination or its control; D2 is the second disambiguation.

Table 3. Sample Passage from Experiment 2 with Regions Marked (Conditions 1 and 2)

| Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. /"Look at this/ C1 cardinal goose"/ said Timmy,/ as a/ D1 light red goose/ came up to/ him. "I prefer the/ C2 banana goose (that goose)="/ said Bill,/ pointing at the/ D2 bright yellow goose/ sitting on/ a rock. Just then the geese took off and flew across the lake./ |
The primary predictions involved region D2. Longer reading times on and more regressions out of this region were expected in the new dimension experimental conditions (3 and 7) than in the parallel dimension experimental conditions (1 and 5). When regressions did occur, they were expected to go back either to C2 (the second combination) or to D1 (the disambiguation of the first combination). Furthermore no disruption was expected in terms of reading time on or regressions out of D2 after control items, as there was no apparent contradiction between a control phrase such as “another x” and its disambiguation. First pass and total time were expected to be longer on experimental items in C2 than on their respective controls, due to simple differences in the text itself together with the assumption that the processing load should be less for a control phrase, “another x” than for a second combination.

The predicted results of parallelism limited to the successful resolution of conceptual combinations (longer reading times in and proportion of regressions out of D2) were never borne out in the various analyses. There was no effect of parallelism due to parallel vs. new dimensions being used in the disambiguation of the first and second combinations that could be attributed only to the experimental items. The only predicted effect which was significant in the analyses was that of control on C2 with the control phrases (e.g. “another x”) being read faster than the experimental combinations. Therefore the current experiment did not support the hypotheses that there would be immediate facilitation in interpreting a second combination based on parallel dimensions.

Other reading time effects which were not predicted did appear, did remain fairly consistent across analyses, and do warrant consideration. These effects, however, hold true for the control as well as for the experimental conditions and therefore are considered
to be dependent upon parallelism as a more general text processing difficulty than on the successful interpretation of conceptual combinations in context. Any conclusions, while they may have implications for non-parallel structures providing a global level of difficulty, do not support an analysis based on conceptual combination resolution per se.

**Full Sentence Reading Time Analyses**

As a gross measure of general processing difficulty, analyses of full sentence reading times were conducted on first pass reading times for two critical sentences. The first sentence analyzed (critical sentence 1) contained the first combination and its disambiguation. The second sentence analyzed (critical sentence 2) contained the second combination (or its relevant control) and its disambiguation. The full set of results is presented in appendix H. The only significant effect was a marginal interaction of dominance x control in critical sentence 2 (F1(1,39) = 5.08, p < .05; F2(1,15) = 3.16, p = .09) indicating that the dominant experimental sentences were read faster than the non-dominant experimental sentences (3800 vs. 4021 ms).

**Initial Analyses of Critical Regions**

The initial analyses on the segmented file were a series of 2 (dominant vs. non-dominant interpretation) x 2 (parallel x new dimension disambiguation) x 2 (experimental vs. control) ANOVAs. These analyses revealed none of the expected effects of parallelism and, because these analyses later were amended to remove 4 items, will not be discussed in detail here. The full first pass means and ANOVA tables appear in Appendix I. Total time means appear in Appendix K.
Bias Norming Study

The fact that the expected results of longer reading times on and regressions out of D2 were not borne out in the initial analyses raised the possibility that perhaps the intended bias of the passages was not achieved. A post-hoc norming study was run in which 13 participants read the passages on paper up to and including the appearance of the second combination (C2). Participants did not read the disambiguating material for the second combination. Instead, participants were asked to generate a definition of the second combination after having read the context of the preceding passage. None of these participants had participated in the previous interpretation studies or in the eyetracking study. In 11 of the 16 passages the intended bias was clearly achieved. In two of the passages the bias clearly was not achieved and three other passages were questionable. On the basis of these results, the 4 worst passages were removed from further analyses. One questionable passage (elephant turtle) was not removed because doing so would have resulted in a completely empty data cell. The passages that were removed are indicated by asterisks in Appendix E.

Tests of Primary Predictions: Selected Items

As the primary predicted effects were expected to appear on D2, the results will first be discussed in terms of effects on D2. A series of 2x2x2 ANOVAs were performed on the selected 12 items. These data provide the clearest representation of the results. First pass means for all conditions are presented in Table 4. The full ANOVA table is presented in Appendix J. Total time means appear in Appendix K.
Table 4. Analyses of Selected Items: First Pass Times (Subject Means)

Ms/Char (raw)

<table>
<thead>
<tr>
<th>Condition</th>
<th>C1</th>
<th>D1</th>
<th>C2</th>
<th>D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: dominant/parallel dimension</td>
<td>46.20 (632)</td>
<td>35.60 (550)</td>
<td>46.21 (648)</td>
<td>32.86 (535)</td>
</tr>
<tr>
<td></td>
<td>cardinal goose</td>
<td>light red goose</td>
<td>banana goose</td>
<td>bright yellow goose</td>
</tr>
<tr>
<td>2: condition 1 control</td>
<td>46.91 (637)</td>
<td>36.42 (553)</td>
<td>30.32 (493)</td>
<td>39.24 (642)</td>
</tr>
<tr>
<td></td>
<td>cardinal goose</td>
<td>light red goose</td>
<td>that goose</td>
<td>bright yellow goose</td>
</tr>
<tr>
<td>3: dominant/new dimension</td>
<td>41.14 (564)</td>
<td>35.55 (698)</td>
<td>35.07 (513)</td>
<td>35.66 (569)</td>
</tr>
<tr>
<td></td>
<td>bread goose</td>
<td>goose eating bread</td>
<td>banana goose</td>
<td>bright yellow goose</td>
</tr>
<tr>
<td>4: condition 3 control</td>
<td>47.62 (649)</td>
<td>37.58 (775)</td>
<td>31.97 (521)</td>
<td>35.92 (606)</td>
</tr>
<tr>
<td></td>
<td>bread goose</td>
<td>goose eating bread</td>
<td>that goose</td>
<td>bright yellow goose</td>
</tr>
<tr>
<td>5: non-dominant/parallel dimension</td>
<td>42.25 (591)</td>
<td>42.49 (836)</td>
<td>40.45 (568)</td>
<td>40.65 (760)</td>
</tr>
<tr>
<td></td>
<td>bread goose</td>
<td>goose eating bread</td>
<td>banana goose</td>
<td>goose eating bananas</td>
</tr>
<tr>
<td>6: condition 5 control</td>
<td>49.11 (681)</td>
<td>42.37 (800)</td>
<td>34.48 (594)</td>
<td>41.07 (754)</td>
</tr>
<tr>
<td></td>
<td>bread goose</td>
<td>goose eating bread</td>
<td>that goose</td>
<td>goose eating bananas</td>
</tr>
<tr>
<td>7: non-dominant/new dimension</td>
<td>42.16 (576)</td>
<td>34.46 (541)</td>
<td>43.36 (607)</td>
<td>44.55 (801)</td>
</tr>
<tr>
<td></td>
<td>cardinal goose</td>
<td>light red goose</td>
<td>banana goose</td>
<td>goose eating bananas</td>
</tr>
<tr>
<td>8: condition 7 control</td>
<td>41.04 (565)</td>
<td>34.92 (555)</td>
<td>32.03 (534)</td>
<td>38.74 (744)</td>
</tr>
<tr>
<td></td>
<td>cardinal goose</td>
<td>light red goose</td>
<td>that goose</td>
<td>goose eating bananas</td>
</tr>
</tbody>
</table>

None of the expected effects of parallelism in D2 were significant in terms of the experimental items alone. First pass and total reading times in D2 did not vary as a result of parallel vs. new dimensions being used in the disambiguations of the second combinations (see Appendix J). The probability of regression out of D2 was predicted to be greater in conditions 3 and 7. The percentages appear in Table 5. There was no apparent effect due to parallel vs. new dimension. There was a significant in a three way interaction of dominance x dimension x control in the regression data ($F_1(1,39) = 3.52, p = .09; F_2 (1, 11) = 3.95, p. 05$) but the pattern of means reveals no consistent effect and is relatively uninterpretable. Taken together, these results show no effect of parallelism between the interpretations of C1 and experimental combinations in C2.
Table 5. Percentage of Regressions Out of Region D2

<table>
<thead>
<tr>
<th>Condition</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15.0</td>
<td>8.3</td>
<td>10.0</td>
<td>18.3</td>
<td>6.7</td>
<td>16.7</td>
<td>13.3</td>
<td>11.7</td>
</tr>
</tbody>
</table>

The main effect of control on C2 was the only predicted effect which proved significant in these analyses. Control items produced shorter reading times than experimental items in first pass (32.20 vs. 41.28 ms/char; F1(1,39) = 30.28, p < .0001; F2(1,11) = 6.74, p < .05) and in total time (40.17 vs. 51.12 ms/char; F1(1,39) = 45.24, p < .001; F2(1,11) = 5.302, p < .05). This is easily accounted for by differences in the text itself. In the control conditions, C2 consisted of phrases such as "another x" rather than a second combination. Control phrases were far less semantically dense and arguably were easier to process.

There was, however, one significant effect on D2 which was not predicted. Dominance was significant by subjects though not by items in both first pass (35.92 vs. 41.25 ms/char; F1(1,39) = 9.93, p < .005; F2(1,11) = 1.44, p > .05) and total time (42.97 vs. 50.05 ms/char; F1(1,39) = 10.50, p < .001; F2(1,11) = 1.36, p > .05). Passages having the dominant meaning as the disambiguation (conditions 1,2,3 & 4) were read faster than those having the non-dominant disambiguation (conditions 5,6, 7 & 8). This suggests that the dominant interpretation may simply have been easier to apply or accept. It must be noted, however, that there were also lexical differences between the dominant and the non-dominant interpretations which may have accounted for the differences in reading time. A related difference between the dominant and non-dominant interpretations is the
fact that the dominant interpretation generally involved a property mapping interpretation whereas the non-dominant interpretations were generally relation linking interpretations or interpretations dependent upon a relational property. In light of the discussion of Experiment 1, it may be that property mapping interpretations led to a name whereas relational interpretations lead to a description of a temporal quality. Relation linking interpretations, then, may simply have been more difficult to compute.

Though the primary predictions of regressions out of D2 were not borne out, reading disruption may still be revealed by looking at second pass times on the regions to which regressions were predicted. In the initial predictions it was assumed, based on parallelism, that if readers had difficulty with the second disambiguation (D2) in the experimental new dimension conditions (conditions 3 and 7) they would re-read either C2 (the second combination) or D1 (the disambiguation of the first combination) as these regions provide information directly relevant to the possible interpretations of the second combination. To examine the results in terms of these predictions, analyses were run on second pass times. Mean second pass times (time spent in region after having left the region moving to the right, ignoring trials on which the regions was skipped) appear in Table 6.
The results of these analyses on second pass times revealed an effect of dimension in C2 which was significant by items and marginally so by subjects (3.49 vs. 5.38 ms/char; F1(1,39) = 3.32, p = .07; F2(1,11) = 5.17, p < .05). Readers spent more time rereading C2 (the second combination) in the new dimension conditions (3, 4, 7 & 8) than in the parallel dimension conditions (1, 2, 5 & 6). There was a similar but marginal effect of dimension on D1 (3.49 vs. 2.17 ms/char; F1(1,39) = 1.54, p > .05; F2(1,11) = 3.53, p = .08) indicating that readers also spent more time rereading D1 (the first disambiguation) in the new dimension conditions (3, 4, 7, and 8) than in the parallel dimension conditions (1, 2, 5, and 6). D1 was the other region that readers were expected to regress to after encountering an alternative disambiguation in D2. There are, however, two caveats to be noted here. First, while predicted only for the experimental items both of these effects held true of the control items as well. Second, a look at the means reveals that this effect was driven by conditions 1-4, the conditions with the dominant meaning as the disambiguation of the first combination; the means in conditions 5-8, while in the right direction, do not show the same differences as those in conditions 1-4.

Table 6. Analyses of Selected Items: Second Pass Times (Subject Means)

Ms/Char

<table>
<thead>
<tr>
<th>Condition</th>
<th>C1</th>
<th>D1</th>
<th>C2</th>
<th>D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: dominant/parallel dimension</td>
<td>2.66</td>
<td>1.77</td>
<td>2.55</td>
<td>2.07</td>
</tr>
<tr>
<td>2: condition 1 control</td>
<td>4.18</td>
<td>1.97</td>
<td>2.58</td>
<td>2.22</td>
</tr>
<tr>
<td>3: dominant/new dimension</td>
<td>4.93</td>
<td>4.41</td>
<td>7.46</td>
<td>3.56</td>
</tr>
<tr>
<td>4: condition 3 control</td>
<td>5.08</td>
<td>2.95</td>
<td>5.76</td>
<td>3.90</td>
</tr>
<tr>
<td>5: non-dominant/parallel dimension</td>
<td>6.34</td>
<td>3.61</td>
<td>5.13</td>
<td>4.29</td>
</tr>
<tr>
<td>6: condition 5 control</td>
<td>3.99</td>
<td>1.66</td>
<td>4.50</td>
<td>4.63</td>
</tr>
<tr>
<td>7: non-dominant/new dimension</td>
<td>8.94</td>
<td>3.43</td>
<td>5.74</td>
<td>2.86</td>
</tr>
<tr>
<td>8: condition 7 control</td>
<td>1.82</td>
<td>2.67</td>
<td>4.12</td>
<td>3.70</td>
</tr>
</tbody>
</table>
In addressing the first caveat, because the pattern held for both experimental and control items, any conclusions drawn from second pass times cannot be based solely on the successful resolution of conceptual combinations. However, it can be argued that the non-parallel nature of the new dimension disambiguations led to difficulty in the resolution of the passage as a whole. In second pass measures, readers now can apply the disambiguating dimension information given them in region D2. In the new dimension conditions, readers may recognize the conflict that that information presents in comparison to the dimension used in D1 and they may therefore re-read either D1 or C2 in an attempt to resolve this conflict. This line of reasoning can explain why the control items also showed the second pass effects as the explanation is based on a more global level of difficulty than on conceptual combination per se.

To address the second caveat, the second pass effects in conditions 5-8 may be explained, in part, by a pattern in the first pass times which will be discussed further after these means have been considered in the section on effects prior to disambiguation.

Dominant Conditions Only: Selected Items

As dominance did lead to significant effects on D2, indicating that the dominant cases were read faster, one possibility is that these cases were the only cases in which the readers successfully computed an interpretation of the second combination. These were also the cases in which the data showed the clearest distinctions between the parallel and new dimension conditions. As a result, a series of 2 (supporting x non-supporting disambiguation) x 2 (experimental vs. control) ANOVAs were run on just the first four conditions, thus eliminating the factor of dominance. The ANOVA tables appear in Appendix L. Means for the dominant conditions appear as conditions 1 through 4 in
Tables 4 and 6. The results of these analyses are essentially the same as those of the overall analyses on all 8 conditions. There still were no significant effects on D2. First pass and total times on D2 and percentage of regressions out of D2 showed no significant effects of parallelism. Again, control remained significant on C2 in first pass (31.15 vs. 40.64 ms/char; F1(1,39) = 20.46, p < .0001; F2(1,11) = 27.38, p < .0001) and in total time (40.47 vs. 51.44 ms/char; F1(1,39) = 15.34, p < .001; F2(1,11) = 5.58, p < .05).

Second pass times (time in region after going past region to the right, ignoring trials on which region was skipped) are revealing in these analyses as well. The effect of dimension became fully significant in C2 (6.61 vs. 2.57 ms/char; F1(1,39) = 6.99, p = .01; F2(1,11) = 11.24, p < .01) and remained marginally significant in D1 (3.49 vs. 2.17 ms/char; F1(1,39) = 2.16, p = .15; F2(1,11) = 4.33, p = .06) with new dimension conditions (conditions 3 and 4) producing longer reading times in D1 and C2 than parallel dimension conditions (conditions 1 and 2) in the same regions. This may account for the lack of inflated reading times on D2. Readers may be rereading previous material rather than remaining in D2 on first pass.

Again, however, these second pass effects held for both the experimental items and their intended controls. The expected interaction of dimension x control was not significant in either region (all Fs < 1). The effect, then, may not be dependent on the successful resolution of conceptual combinations per se so much as on the difficulty of having a shift in dimensions explicated in the differing disambiguations.

Effects Prior to Disambiguation: Selected Items

The initial hypotheses predicted that any effects of parallelism should appear on D2 and that there should be no differences in reading times between the experimental
items on C2 because at that point the reader would have no knowledge about the parallelism, or lack thereof, of the second combination's disambiguation.

A consistent effect did appear on C2, however, and warrants consideration. In the analyses of all 8 conditions, the three way interaction of dominance x dimension x control was fully significant in first pass times on C2 ($F(1,39) = 9.25, p < .005; F(1,11) = 6.18, p < .05$). In the first four conditions (1-4) while the difference among the control items (conditions 2 and 4) was minimal (30.32 vs. 31.97 ms/char), the parallel dimension experimental case, condition 1, had longer reading times than the new dimension experimental case, condition 3 (46.21 vs. 35.07 ms/char). The pattern is reversed for the second four conditions (5-8). Here the new dimension experimental case, condition 7, produced longer reading times than the parallel dimension experimental case, condition 5 (43.36 vs. 40.45 ms/char). This may be explained by the fact that the dominant interpretation may have been an easier interpretation to apply to C2. In cases where the disambiguation of C1 presumably primes the dominant interpretation of C2 (conditions 1 and 7), readers may actually attempt to apply this dominant interpretation to C2 before moving on to its disambiguation. This would explain longer first pass reading times in these conditions. In conditions 3 and 5, however, the reader may be less able to apply the non-dominant interpretation given in D1 to the novel combination in C2 and may therefore leave the combination underspecified, proceeding on without disruption. This argument, however, cannot account for why, if the reader has computed an analysis on C2 in condition 7 (non-dominant/new-dimension/experimental), he or she does not then boggle when this analysis is revealed to be incorrect in D2.
This first pass pattern may also explain why the second pass effects on C2 were greater in conditions 1-4 than in conditions 5-8. In the experimental new dimension condition where readers had relatively short first pass times (condition 3) second pass times were relatively long whereas in the experimental new dimension condition where readers had relatively long first pass times (condition 7) second pass times were relatively short. So, while the expected second pass patterns appeared primarily in conditions 1-4, with condition 3 producing longer times than condition 1, the lesser effects in conditions 5-8 may be tempered by the fact that condition 7 showed the effects in first pass times resulting, perhaps, in less need for rereading.

Conclusions

The purpose of this experiment was to investigate the on-line interpretation of N-N combinations in context and the impact which successful resolution of one combination may have on the interpretation of a second combination later in the same passage. It was assumed that if a second combination utilized a parallel dimension to that used in the interpretation of the first combination, interpretation of that second combination would be easier than interpretation of a second combination which required the use of a non-parallel or new dimension.

Contrary to predictions, there were no effects of immediate disruption in the second disambiguating region due that could be attributed solely to parallel interpretations of the experimental items. This was true across analyses. Any effects of parallel dimensions were evident in the control conditions as well as in the experimental conditions. This suggests that there may have been a more general text processing
difficulty based on information received about parallel dimensions but not based on immediate successful resolution of the N-N combinations themselves.

The only effect that was significant in D2 was that of dominance in the analyses on all 8 conditions. D2 was read faster in the dominant disambiguation conditions (1-4) than in the non-dominant disambiguation conditions (5-8). It could be argued that the dominant disambiguation was simply easier to apply. It must be noted, however, that there were also lexical differences between the dominant and non-dominant disambiguations which may account for the differences in reading times.

Though not intended, another possible explanation for the effect of dominance is that there were differences in the representations required by the different disambiguations. Though the passages were not designed to have particular interpretations use property mapping and others use relation linking, post-hoc examination of the experimental materials revealed that these strategies may have had an effect in these results as well. In 12 of the 16 experimental passages, the dominant disambiguation utilized a property mapping interpretation while the non-dominant disambiguation relied on a relation linking interpretation. As discussed in Experiment 1, property mapping interpretations are dominant for natural kinds. As all but one of the combinations used in the present study were natural kinds this may have led to the dominant, property mapping interpretations being easier to process than the non-dominant interpretations which required more relational analyses.

Looking at the results of the bias norming study, those four items which were removed from the analyses on selected items were in fact the four combinations which had relation linking interpretations as their dominant interpretations. Therefore the above
explanation is even more relevant to the fact that dominance remained significant in the amended analyses where these four items were removed.

Though the expected effects of immediate disruption were not found, there were consistent effects in reading time which appeared in the region containing the second combination (C2). Reading time in the control conditions was shorter than it was for the experimental conditions. This was expected given that the controls were less semantically dense than the experimental combinations and therefore were expected to require less processing time.

There were also some unexpected effects in C2. First pass times were longer in condition 1 (dominant/parallel dimension/experimental) than in condition 3 (dominant/new dimension/experimental) and in 7 (non-dominant/new dimension/experimental) than 5 (non-dominant/parallel dimension/experimental). In conditions 1 and 7 (those conditions in which reading times were longer) the dimension used in D1 presumably primes the dominant interpretation of C2 (e.g. yellow goose for banana goose). It may be that in conditions 1 and 7 the reader takes the time to apply this parallel dimension to C2 (e.g. color for banana goose from light red for cardinal goose) before moving on to the disambiguating material in D2. Readers may therefore take longer on C2 and, in turn, avoid boggling on D2. In contrast, when reading C2 in the conditions 3 and 5, which presumably prime the non-dominant interpretation of C2 (e.g. eats for banana goose), the reader may reach the combination in C2 and have difficulty computing a parallel interpretation of C2 because the non-dominant interpretation is more difficult to apply. First pass times indicate that readers proceed through this region relatively quickly suggesting that they may leave the combination in C2 underspecified.
and may wait for further information. The inability to compute an interpretation of C2 in conditions 3 and 5 may be due to the relational nature of D1. In the control conditions (2, 4, 6 and 8), readers may not yet compute the interpretation, instead waiting for further information to disambiguate the relatively uninformative phrase “another x”, resulting in shorter first pass times.

This conclusion is quite post-hoc however and is prey to a few criticisms. For one, it does not explain what might be going on in conditions 3 and 5 except to say that perhaps in these conditions, the reader is leaving the interpretation underspecified. Nor does it explain why in condition 7, if readers have successfully arrived at an interpretation of C2 which is then disconfirmed in D2, there is no disruption in D2 based on this disconfirming information. It may be that readers allow the second combination to remain underspecified in all conditions and that even the disambiguation in D2 does not allow them to successfully compute an interpretation in all conditions. This might explain why there is no disruption in D2 in condition 7.

Another factor which might explain the lack of disruption in condition 7 is that if readers have indeed computed an interpretation of C2 based on information in D1 which biased them towards the dominant interpretation, they may have computed a property mapping interpretation for C2 (e.g. a banana goose being yellow after being primed with a cardinal goose being red). Property mapping interpretations are predominant for natural kinds and, it has been suggested, may provide a more constant name. In these cases, it may be that when information in D2 suggests a relational interpretation of C2, this suggestion does not entirely conflict with having already arrived at a name interpretation. A banana goose might well be a yellow goose which also happens to be eating bananas at
the particular time of mention. In this case, the information in D2 does not necessarily disconfirm or conflict with the interpretation arrived at for C2 and therefore the reader may proceed without disruption.

Though the primary predictions of immediate disruption for experimental items only (longer first pass reading times in and regressions out of D2) did not appear, second pass times did show evidence of disruption based on new dimension disambiguations in D2 (conditions 3, 4, 7 & 8). In experimental condition 3 (dominant/new dimension), while the combination may have remained underspecified at first (suggested by the shorter first pass times in this condition), the dominant disambiguation in D2 may provide information that is easier to apply than the information given in condition 7. The reader, therefore, may realize that they can indeed compute an interpretation of the combination in C2 and as a result may regress and spend more time re-reading C2 as is evidenced by the second pass times. This pattern is not as dramatic for the new dimension conditions in the non-dominant cases. This could be explained by the combination remaining underspecified throughout in condition 7 as explained above. This underspecification may be a result of the relational interpretation being less transparent and the reader being less likely to try to such an interpretation.

Any conclusions drawn from an effect of dimension on second pass times, however, must be hedged by the fact that this effect applies to both experimental and control items. The control conditions were not expected to show second pass effects and they certainly were not expected to pattern with their respective experimental items. The fact that the controls do show the same effects can be explained in a number of ways. One argument is simply that the effects are not due to the successful analyses of
conceptual combinations but rather that the difficulty lies simply in the shift in dimensions between the disambiguation in D1 and that in D2. This would imply more of a general text processing difficulty rather than a direct effect of conceptual combination.

Another possible explanation for the control effects is that, even though they were not expected to require the same resolution as the actual combinations, readers may still attempt to interpret them once they receive relevant information from the disambiguations. Once the reader is given information about the dimension to be used, the reader may attempt to apply this dimension to the uninformative phrase “another x” in order to achieve some distinction between that item and the rest of the members of its set. Readers may attempt to apply the parallel dimension to the intended control (e.g. “another x”) as well as to the actual combinations.
CHAPTER 5

GENERAL DISCUSSION

The current investigations addressed the issue of the interpretation of novel N-N combinations. Two experiments were conducted which examined factors affecting these interpretations in and out of context. The first experiment investigated strategies of conceptual combination, the factors that influence which of these strategies are chosen, and how information is utilized within them. The experiment was concerned in particular with the effects of different ontological categories, varying feature salience, and possible correlations with similarity. The second experiment examined the effects of the use of shared dimensions on the interpretation of two novel N-N combinations in context. The primary predictions were that second combinations utilizing information from dimensions parallel to those used to interpret earlier combinations would be easier to interpret than those introducing and requiring the use of new dimensions.

The first experiment indicated that feature salience did indeed influence the interpretations produced. High salience modifiers led to more property mapping interpretations and these interpretations generally were driven by the salient feature of N1. There were also some effects to suggest the importance of the salience of N2. Highly salient features on N2 led to more switching errors being produced.

These results were achieved from randomly paired nouns suggesting that feature salience is an important factor and is at least somewhat independent of the relationship between the nouns. However, such random pairing may have led to some implausible combinations (e.g. knife carpet) in which the salient features from the modifier could not be applied to the head because of constraining aspects of the head. Murphy’s Concept
Specialization Model (1988, 1990) addresses the need for elaboration of a simple slot filling process based on world knowledge. Such an elaboration process may well explain such effect. Furthermore, such aspects are not necessarily high salience features (as is suggested by the fact that carpet was rated as low salience for any one feature but was still constraining). Rather, such aspects may be relevant dimensions. Estes and Glucksberg (in press) manipulated the modifier feature salience and head dimension relevance to that feature (light being a high salience feature for feather and weight being a dimension of the head luggage which is highly relevant to the modifier feature in the combination feather luggage). They found that more property attributions were produced for such combinations than for combinations which had either low feature salience modifiers, low dimension relevance heads, or both.

Previous research has revealed strong positive correlations between the proportion of property mapping interpretations and the assessed similarity of two nouns. This effect was not replicated in the current study. There were no correlations between property mapping and similarity. Rather than disavow claims based on similarity, the current experiment suggests that there might be strategies which are even more informative and perhaps more economical than similarity comparisons. These strategies may rely on the salience of particular features. Information about which features are likely candidates for the creation of a N-N combination may lead to a more economical strategy of interpretation than exhaustive similarity comparisons and alignment procedures. Salient features may provide such information by exemplifying the distinctions between different instances of a head class.
This may be especially true for natural kinds as is evidenced by the predominance of property mapping interpretations for pairs within this ontological category. Salient features often provide information about what distinguishes the instance from other members of its class. In natural kinds, visual attributes often form the basis for such distinctions. Visual attributes are generally the salient features of natural kind terms and such attributes lend themselves well to property mapping interpretations. For artifacts, the salient features, while they may be attributes, often are related to the artifact's function. This difference in the types of features that are rated as salient may lead to a predominance of property mapping interpretations for natural kinds in comparison to artifacts. Property mapping interpretations may be more likely to result in a name based on a visual dimension and may therefore be highly appropriate for natural kind pairs. Relation linking may result in a more functional or temporal description of a pair and may therefore be more applicable to artifacts.

Experiment 2 investigated the interpretation of N-N combinations in context. An online reading study was conducted with passages which contained two N-N combinations. The second combinations in the passages either used a dimension parallel to that used in the interpretation of the first combination or introduced a new dimension that was not parallel to that used in the first combination. Immediate disruption of reading was expected in the conditions which required introduction and use of a non-parallel dimension. Such effects were never found to be limited to the experimental conditions. There was no disruption due to applying information about the dimension used in the successful resolution of a first combination to the interpretation of a second combination.
An effect of parallel dimension did appear but held for control items as well as for experimental items. This effect appeared in second pass reading times after participants read the second disambiguating region. This effect suggests that there was a more general text processing difficulty associated with the shift in dimensions from one disambiguating region to another. The difficulty was not, however, dependent upon the successful resolution of the second combination prior to its disambiguation. Rather, after reading the second disambiguating region, readers applied information from that region to both the experimental combinations and to their intended controls in C2. The fact that, even in the dominant conditions for which the pattern seemed closest to the predicted results, the effects of parallelism were not limited to experimental items suggests a more global text processing difficulty.

There was also an effect of dominance in reading the second disambiguating region (D2) in Experiment 2. Disambiguations which supported the dominant interpretations of the second combinations were read faster than the disambiguations which supported the non-dominant interpretations. This effect may be due to lexical differences between the two disambiguations. The effect may also be due, however, to differences in the representations underlying these interpretations. The dominant interpretations simply may have been easier to apply. The distinction between name and temporal quality interpretations discussed in Experiment 1 is relevant here. The dominant interpretations of the N-N combinations in this experiment were generally property mapping interpretations and the non-dominant were relation linking. Given that all but one of the combinations were natural kind combinations, property mapping interpretations may simply have been easier to process, leading to the dominance effect.
Furthermore, when the dominant interpretation was primed and then disconfirmed readers did not show the expected disruption. This may be because the dominant interpretation resulted in a name and was able to accept a secondary relational description as well (a banana goose can be a yellow goose and this is not necessarily disconfirmed by the fact that the goose is also eating bananas at a particular time). However, when the non-dominant interpretation was primed and was then disconfirmed by the dominant disambiguation, disruption did occur. In these cases, readers may simply have left the combination underspecified as discussed in Chapter 4.

The fact that the expected effects of parallelism never appeared for the experimental conditions alone also may be due to the on-line methodology of the experiment. Gerrig and Murphy (1992) noted that when readers were presented with numerous such combinations in an on-line reading study, the authors felt that the readers simply stopped attempting to interpret the combinations. As a result, in investigating the possible facilitatory effect of shared relations between combinations, Gerrig and Murphy chose to do an off-line interpretation study (Experiment 4). The methodology in that study was very similar to the methodology of the bias norming study presented in here Experiment 2. The bias norming study indicated that for the selected 12 items, the intended bias was indeed produced. Therefore, it was not a matter of the passages not setting up the intended bias. Rather it may be that, in an on-line reading situation, readers leave these combinations underspecified unless there is an interpretation which is easy to apply as might be the case in the dominant interpretations in the current study. If the reader is forced to provide an interpretation, as in the off-line studies, the expected effects of parallel dimension priming the interpretation of the second combination do appear.
In sum, the first experiment did not support previous findings that similarity plays a significant role in determining when property mapping will be the selected strategy for conceptual combinations. The present study identified two other factors which were shown to predict the strategies chosen: ontological category and feature salience. The study suggested that further investigations of salience will be informative. Salience was an important factor even for combinations in which the relevant dimensions of the head were not manipulated. Therefore, salience alone can be viewed as an informative factor though it may be even more so when the head relevance is controlled as in Estes and Glucksberg (in press). Furthermore there may be other constraints which lead salience to be an even more informative factor. The ability to identify which salient features are relevant may be a more economical approach than more general similarity comparisons.

The second study yielded surprising results. The predicted effects of parallel dimension on the immediate interpretation of the second combination were not borne out. Readers did not necessarily commit to a particular interpretation of a combination. Instead, all effects of parallelism seemed to be due to a shift of dimensions in the disambiguating material after both experimental combinations and their intended controls. This result suggests a more general text processing difficulty and implies that readers may not successfully interpret combinations in context unless forced to do so by a particular task such as that used in the bias norming study. Therefore it may be that such effects will not appear in on-line reading studies unless a task is incorporated which forces the reader to generate an interpretation or unless the context somehow becomes absolutely anomalous if the reader has not interpreted the second combination.
### APPENDIX A

#### LIST OF WORDS NORMED FOR SALIENCE

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### APPENDIX B

#### HIGH SALIENCE TALLY

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APPENDIX B
### APPENDIX C:
LISTS OF COMBINATIONS INTERPRETED IN EXPERIMENT I

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<td>door truck</td>
<td>bureau hat</td>
<td>ladder lamp</td>
<td>carpet bureau</td>
</tr>
<tr>
<td>drum roof</td>
<td>desk door</td>
<td>hat sweater</td>
<td>shirt carpet</td>
</tr>
<tr>
<td>sweater newspaper</td>
<td>stick lamp</td>
<td>freezer triangle</td>
<td>tie television</td>
</tr>
<tr>
<td>triangle car</td>
<td>truck sweater</td>
<td>lamp taxi</td>
<td>magazine stick</td>
</tr>
<tr>
<td>taxi doll</td>
<td>television puzzle</td>
<td>puzzle stove</td>
<td>shovel tie</td>
</tr>
<tr>
<td>spear belt</td>
<td>car ball</td>
<td>bicycle spear</td>
<td>doll shovel</td>
</tr>
<tr>
<td>ball bureau</td>
<td>plate bicycle</td>
<td>triangle ball</td>
<td>pencil boot</td>
</tr>
<tr>
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<td>scarf mirror</td>
<td>sandpaper window</td>
<td>boot desk</td>
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<tr>
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<td>roof stove</td>
<td>strainer puzzle</td>
<td>chimney plate</td>
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<td>belt window</td>
<td>drum mirror</td>
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<tr>
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<td>carpet ladder</td>
<td>stove knife</td>
<td>bureau truck</td>
</tr>
<tr>
<td>freezer stick</td>
<td>shirt knife</td>
<td>door bicycle</td>
<td>desk roof</td>
</tr>
<tr>
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<td>sweater ladder</td>
<td>stick newspaper</td>
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<tr>
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<td>magazine taxi</td>
<td>chair hat</td>
<td>truck doll</td>
</tr>
<tr>
<td>puzzle scarf</td>
<td>shovel chair</td>
<td>taxi freezer</td>
<td>television car</td>
</tr>
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</table>
APPENDIX D
EXAMPLE PACKET OF MATERIALS FOR EXPERIMENT 1

Salience Ratings:

Instructions:
Hi.
Thanks for participating in our study. On the following pages you will find a list of noun pairs. Please read the pairs and then list two possible interpretations for each pair. There are no right or wrong answers in this task. You may never have seen many of these noun pairs. Just write down what you think the best interpretation to be. If you have any questions, feel free to ask the experimenter.

<table>
<thead>
<tr>
<th>window door</th>
<th>tiger mouse</th>
<th>coconut butterfly</th>
<th>mirror sandpaper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
<td>1.</td>
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</tr>
<tr>
<td>2.</td>
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<table>
<thead>
<tr>
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<th>shovel tie</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
<td>1.</td>
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<tr>
<td>2.</td>
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<table>
<thead>
<tr>
<th>triangle car</th>
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<th>crowd worm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
<td>2.</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>flamingo scarf</th>
<th>mule rhinoceros</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
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<table>
<thead>
<tr>
<th>acorn magnolia</th>
<th>worm petunia</th>
<th>daisy sparrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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<td>2.</td>
<td>2.</td>
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</tbody>
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<table>
<thead>
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<th>flamingo potato</th>
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<table>
<thead>
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<th>ladder lamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
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<table>
<thead>
<tr>
<th>elephant turtle</th>
<th>truck sweater</th>
<th>puzzle stove</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
<td>1.</td>
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<tr>
<td>2.</td>
<td>2.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>wasp elm</th>
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<th>lily crow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
<td>2.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>lark crocus</th>
<th>plate belt</th>
<th>sand centipede</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
<td>2.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ant wasp</th>
<th>newspaper spear</th>
<th>butterfly raisin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
<td>2.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>roof shirt</th>
<th>doll triangle</th>
<th>moose robin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
<td>2.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>coconut butterfly</th>
<th>mirror sandpaper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
</tr>
</tbody>
</table>
Additional 10 words normed for salience:

Instructions:
Hi. Thanks for participating in our study. On the following pages you will find a series of words and rating scales. For each item you are asked to list the most salient feature of that item (the feature which is most likely to come to mind when you think of the item, the feature which is easiest to think of, the feature which stands out the most). For instance: if the word were FLAMINGO, the feature which comes to mind first might be PINK. You are then asked to rate the salience of the feature you gave. The rating scale ranges from 1 to 7 with 1 being least salient and 7 having the highest salience. For instance: for FLAMINGO, the feature PINK is a highly salient feature (really stands out) so you might rate it 6 or 7.

In contrast, if the item were WREN, there might not be any very salient features. So you might list BROWN as a feature but only give it a salience rating of 2 or 3.

You are given the option of listing two features for an item. Feel free to do so if you feel that an item has more than one defining characteristic. Do not feel that you must list more than one feature. Do so only if you think it appropriate. For instance: FLAMINGO might have two salient features (PINK and STANDS ON ONE LEG) whereas WREN might not have any very salient features and therefore you wouldn’t fill in the second feature blank.

If when listing a feature you find that you can only do so by using a phrase rather than a single word, go ahead and use a phrase (i.e. runs fast, stands on its head, has blue feet)

Example:

<table>
<thead>
<tr>
<th>FLAMINGO:</th>
<th>WREN:</th>
</tr>
</thead>
<tbody>
<tr>
<td>feature PINK</td>
<td>feature BROWN</td>
</tr>
<tr>
<td>salience 1 2 3 4 5 6 7</td>
<td>salience 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>feature STANDS ON ONE LEG</td>
<td>feature BLANK</td>
</tr>
<tr>
<td>salience 1 2 3 4 5 6 7</td>
<td>salience 1 2 3 4 5 6 7</td>
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</tbody>
</table>

Materials normed:

<table>
<thead>
<tr>
<th>leopard</th>
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</thead>
<tbody>
<tr>
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<td>feature:</td>
</tr>
<tr>
<td>salience: 1 2 3 4 5 6 7</td>
<td>salience: 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>goose:</td>
<td>octopus:</td>
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<tr>
<td>feature:</td>
<td>feature:</td>
</tr>
<tr>
<td>salience: 1 2 3 4 5 6 7</td>
<td>salience: 1 2 3 4 5 6 7</td>
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<tr>
<td>ostrich:</td>
<td>snail:</td>
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<tr>
<td>feature:</td>
<td>feature:</td>
</tr>
<tr>
<td>salience: 1 2 3 4 5 6 7</td>
<td>salience: 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>salamander:</td>
<td>mug:</td>
</tr>
<tr>
<td>feature:</td>
<td>feature:</td>
</tr>
<tr>
<td>salience: 1 2 3 4 5 6 7</td>
<td>salience: 1 2 3 4 5 6 7</td>
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<tr>
<td>canary:</td>
<td>tire:</td>
</tr>
<tr>
<td>feature:</td>
<td>feature:</td>
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<tr>
<td>salience: 1 2 3 4 5 6 7</td>
<td>salience: 1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>
Similarity Ratings:
On the following pages you will find another series of noun pairs.
For these pairs, you are asked to rate the similarity of the words on a scale from 1 to 7.
7 means the words are very similar
1 means they are not similar at all.
For example, a tiger may be more similar to a moose than to a fish.
a cat may be more similar to a dog than to a tree.
so:
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>tiger</td>
<td>moose</td>
</tr>
<tr>
<td>fish</td>
<td>tiger</td>
</tr>
</tbody>
</table>

a car may be more similar to a truck than to a frisbee
so:
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>car</td>
<td>truck</td>
</tr>
<tr>
<td>car</td>
<td>frisbee</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>window door</th>
<th>sandpaper plate</th>
<th>doll triangle</th>
<th>moose robin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>leopard carpet</td>
<td>tiger mouse</td>
<td>desk door</td>
<td>carrot beetle</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>triangle car</td>
<td>tie television</td>
<td>coconut butterfly</td>
<td>rooster leech</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>centipede rhinoceros</td>
<td>zebra pencil</td>
<td>shovel tie</td>
<td>mirror sandpaper</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>acorn magnolia</td>
<td>flamingo scarf</td>
<td>crow worm</td>
<td>chair boot</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>robin mule</td>
<td>worm petunia</td>
<td>mule rhinoceros</td>
<td>robin termite</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>banana goose</td>
<td>magnolia flamingo</td>
<td>daisy sparrow</td>
<td>carpet bureau</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>elephant turtle</td>
<td>boot strainer</td>
<td>flamingo potato</td>
<td>lamp taxi</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>wasp elm</td>
<td>truck sweater</td>
<td>ladder lamp</td>
<td>drum roof</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>lark crocus</td>
<td>mule rhinoceros</td>
<td>puzzle stove</td>
<td>banana robin</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
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<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>ant wasp</td>
<td>beetle pine</td>
<td>lily crow</td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>roof shirt</td>
<td>plate belt</td>
<td>sand centipede</td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>strainer desk</td>
<td>newspaper spear</td>
<td>butterfly raisin</td>
<td></td>
</tr>
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<td>1 2 3 4 5 6 7</td>
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<td>1 2 3 4 5 6 7</td>
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APPENDIX E
SIXTEEN COMBINATIONS USED IN EXPERIMENT 2
AND RESULTS OF BIAS NORMING STUDY

<table>
<thead>
<tr>
<th>Combination Used</th>
<th>Contextual Bias to Dominant Meaning</th>
<th>Contextual Bias to Secondary Meaning</th>
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<td>Secondary Given</td>
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<td>0</td>
</tr>
<tr>
<td>flamingo potato</td>
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<td>0</td>
</tr>
<tr>
<td>potato wasp</td>
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<td>0</td>
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<td>wasp elm*</td>
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<td>0</td>
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<tr>
<td>mouse pine</td>
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<td>0</td>
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<td>moose ant*</td>
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<td>3</td>
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<tr>
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<td>0</td>
</tr>
<tr>
<td>carrot beetle</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: “Other” often consisted of responses which merely defined the head noun (i.e. “turtle”)

* Item removed from final analyses based on bias norming study

( ) dominant response mentioned after secondary interpretation given
APPENDIX F
FULL SET OF EXPERIMENTAL PASSAGES FOR EXPERIMENT 2

Banana Goose
Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. “Look at this cardinal goose” said Timmy, as a light red goose came up to him. “I prefer the banana goose” said Bill, pointing at the bright yellow goose sitting on a rock. Just then the geese took off and flew across the lake.

Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. “Look at this cardinal goose” said Timmy, as a light red goose came up to him. “I prefer that goose” said Bill, pointing at the bright yellow goose sitting on a rock. Just then the geese took off and flew across the lake.

Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. “Look at this bread goose”, said Timmy, referring to a goose eating bread right out of his hand. “I prefer the banana goose” said Bill, pointing at the bright yellow goose sitting on a rock. Just then the geese took off and flew across the lake.

Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. “Look at this bread goose”, said Timmy, referring to a goose eating bread right out of his hand. “I prefer that goose” said Bill, pointing at the bright yellow goose sitting on a rock. Just then the geese took off and flew across the lake.

Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. “Look at this bread goose”, said Timmy, referring to a goose eating bread right out of his hand. “I prefer the banana goose” said Bill, pointing at the goose eating bananas from his hand. Just then the geese took off and flew across the lake.

Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. “Look at this bread goose”, said Timmy, referring to a goose eating bread right out of his hand. “I prefer that goose” said Bill, pointing at the goose eating bananas from his hand. Just then the geese took off and flew across the lake.

Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. “Look at this cardinal goose” said Timmy as a light red goose came up to him. “I prefer the banana goose” said Bill, pointing at the goose eating bananas from his hand. Just then the geese took off and flew across the lake.

Bill and Timmy were going for a walk by the pond. They had a bag of food to feed the birds. They started feeding some birds. “Look at this cardinal goose” said Timmy as a light red goose came up to him. “I prefer that goose” said Bill, pointing at the goose eating bananas from his hand. Just then the geese took off and flew across the lake.

Elephant Turtle
Mary really liked the reptile house at the zoo. They had reptiles from all over the world. One of the tanks had a horse turtle. He was the largest turtle in his tank. Mary's favorite, though, was the elephant turtle. He was so gigantic that he had a tank all to himself. Mary liked to try to remember where all the different reptiles were from.

Mary really liked the reptile house at the zoo. They had reptiles from all over the world. One of the tanks had a horse turtle. He was the largest turtle in his tank. Mary's favorite, though, was a different turtle. He was so gigantic that he had a tank all to himself. Mary liked to try to remember where all the different reptiles were from.
Mary really liked the reptile house at the zoo. They had reptiles from all over the world. One of the tanks had a giraffe turtle. His long neck let him reach food high up. Mary’s favorite, though, was the elephant turtle. He was so gigantic that he had a tank all to himself. Mary liked to try to remember where all the different reptiles were from.

Mary really liked the reptile house at the zoo. They had reptiles from all over the world. One of the tanks had a giraffe turtle. His long neck let him reach food high up. Mary’s favorite was the elephant turtle. His long snout let him reach food all the way at the end of his tank. Mary liked to try to remember where all the different reptiles were from.

Mary really liked the reptile house at the zoo. They had reptiles from all over the world. One of the tanks had a giraffe turtle. His long neck let him reach food high up. Mary’s favorite was a different turtle. His long snout let him reach food all the way at the end of his tank. Mary liked to try to remember where all the different reptiles were from.

Mary really liked the reptile house at the zoo. They had reptiles from all over the world. One of the tanks had a horse turtle. He was the largest turtle in his tank. Mary’s favorite was the elephant turtle. His long snout let him reach food all the way at the end of his tank. Mary liked to try to remember where all the different reptiles were from.

Mary really liked the reptile house at the zoo. They had reptiles from all over the world. One of the tanks had a horse turtle. He was the largest turtle in his tank. Mary’s favorite was a different turtle. His long snout let him reach food all the way at the end of his tank. Mary liked to try to remember where all the different reptiles were from.

Daisy Sparrow
Natalie Todd was an ornithologist who spent years cataloguing the birds of the Mid-Atlantic states. One of her primary focuses was the leopard sparrow. Its black and yellow spots make this bird easy to identify. Later in her career, Todd also studied the daisy sparrow. Its white and yellow feathers are quite striking. Todd’s studies are well documented in her books.

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Termite Sparrow
Small birds have varied diets depending on their habitats. The ant sparrow eats ants that it gathers by waiting by ant hills. The termite sparrow also has a restricted diet. This bird eats termites found only in rotting trees. Such a diet limits its habitat to areas with a large number of dead trees.

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Small birds have varied diets depending on their habitats. The wheat sparrow eats wheat stalks. It builds its nest by wheat fields and migrates when the growing season is over. The termite sparrow also has a restricted diet. This bird eats termites found only in rotting trees. Such a diet limits its habitat to areas with a large number of dead trees.

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Crow Worm
It had been raining all day and Kate noticed all the different worms on the ground. She decided to do her science project on worms. One species she read about was the fire worm. She thought this worm's red color was really pretty. She also read about the crow worm. This worm's black shiny skin gave Kate the creeps so she decided not to use it in her report. Kate was surprised by how many species of worms there are.

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Moose Crow
Peter and Julie are avid bird watchers. One day, Peter spotted a moose crow. He and Julie were amazed that it was so enormous. They had never seen a crow so big. A little while later, Julie pointed to a rhinoceros crow. The large size of this bird made it easy to see among the small branches. Satisfied with their sightings for the day, Peter and Julie started to head home.

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**Flamingo Scarf**

Sarah has a large collection of scarves. She has a different scarf for almost any occasion. Her favorite scarf is the dandelion scarf. Its bright yellow color always cheers her up so she wears it on days when she is feeling down. Sarah also likes the flamingo scarf. Its shocking pink color doesn't match with many of her clothes so Sarah doesn't wear it often.

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Sarah has a large collection of scarves. She has a different scarf for almost any occasion. Her favorite scarf is the kitten scarf. The print of kittens always cheers her up so she wears it on days when she is feeling down. Sarah also likes the flamingo scarf. Its shocking pink color doesn't match with many of her clothes so Sarah doesn't wear it often.

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**Flamingo Potato**

Martha was demonstrating variations on traditional potato salad. She was emphasizing the use of exotic potatoes. Today she was making one of her personal favorites. She mixed in a ruby potato which lent the salad a deep red color. Her next addition was a flamingo potato. She explained how this potato’s bright pink hue accented the salad nicely. Martha hoped that exotic potato salads would become a picnic fad.

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**Potato Wasp**

One of the worst pests a farmer can encounter is the turnip wasp. This bug chews turnip plants, leaving a chemical that makes the leaves of young plants turn brown and die. Another farm pest is the potato wasp. This bug eats potatoes so quickly that it can destroy an entire crop in a week. There are pesticides that farmers can use to try to eliminate these pests.

One of the worst pests a farmer can encounter is the turnip wasp. This bug chews turnip plants, leaving a chemical that makes the leaves of young plants turn brown and die. Another farm pest is a different wasp. This bug eats potatoes so quickly that it can destroy an entire crop in a week. There are pesticides that farmers can use to try to eliminate these pests.

One of the worst pests a farmer can encounter is the cauliflower wasp. This wasp, identified by the white bumps on its shell, is very difficult to get rid of once it has invaded. Another farm pest is the potato wasp. This bug eats potatoes so quickly that it can destroy an entire crop in a week. There are pesticides that farmers can use to try to eliminate these pests.

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**Wasp Elm**

Tina’s class was learning about different types of trees. They were learning about how some trees protect animals and how others defend themselves against predators. One tree they studied was the butterfly elm. Tina read that butterflies lay their eggs on this tree. The class also studied the wasp elm. This tree often has wasp nests on it. The large leaves protect the wasps from predators.
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Tiger Mouse
Judy and her mother were at the mouse circus where mice of all kinds looked and acted like the animals at the regular circus. “Look Judy, there's a leopard mouse!”, said her mother, pointing to a spotted mouse in a cage. Judy said that her favorite was the tiger mouse. His black stripes made him stand out from all the rest. Afterwards, Judy and her mother went outside to feed peanuts to the elephants.

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Mouse Pine
Cindy and Lewis just bought a plot of land. When they were surveying the property they took note of the different trees on the land. Cindy loved the elephant pine. She thought that its large size would provide good shade for a hammock. Lewis agreed but said that he preferred the mouse pine. He was amazed that such a small tree could be full grown. He wanted to put a fence around it to protect it.

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Cindy and Lewis just bought a plot of land. When they were surveying the property they took note of the different trees on the land. Cindy loved the rabbit pine. She thought the rabbits living in its roots were really cute. Lewis agreed but said that he preferred the mouse pine. He was amazed that such a small tree could be full grown. He wanted to put a fence around it to protect it.

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**Pine Lily**
Katherine was planning an elaborate dinner party. She wanted to make a unique flower arrangement for the table. The florist recommended the bush lily. Because this lily grows on large bushes it would provide lovely foliage to complement the arrangement. Katherine preferred the pine lily. This lily grows on evergreens and seemed quite unique to her. She ordered a dozen for the table arrangement.

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**Moose Ant**
Jonathan and Alex were building an ant farm. They were going to raise ants as a summer project. One kind of ant they were going to farm was the hippo ant. They were making the farm really wide to accommodate the enormous size of these ants. The boys were also going to breed the moose ant. This ant is the largest bred in captivity. Jonathan and Alex were hoping that both ants would thrive in their farm.
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**Robin Snake**

Certain tribes in Australia celebrate the beginning of the hunting season with a traditional snake hunt. Different species of snakes bring different levels of esteem to the hunter that catches them. The canary snake is one snake often brought in from the hunt. Its bright yellow color makes it easy to catch. The robin snake is an even more highly prized catch. This snake’s red underbelly symbolizes the hunt. The first hunter to catch one receives great honors.

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Certain tribes in Australia celebrate the beginning of the hunting season with a traditional snake hunt. Different species of snakes bring different levels of esteem to the hunter that catches them. The canary snake is one snake often brought in from the hunt. Its bright yellow color makes it easy to catch. A different snake is an even more highly prized catch. This snake feeds on robins which are sacred birds. The first hunter to catch one receives great honors.

**Carrot Beetle**

Many farmers have an ongoing struggle with controlling beetle populations in their crops. It is easy to tell when the lemon beetle has infested a crop. It’s shiny yellow shell is a dead giveaway. This makes it easy to exterminate. The carrot beetle is also easy to catch early. This beetle’s bright orange color makes it easy to spot on green leaves. This allows farmers to catch an infestation before it spreads too far.

Many farmers have an ongoing struggle with controlling beetle populations in their crops. It is easy to tell when the lemon beetle has infested a crop. It’s shiny yellow shell is a dead giveaway. This makes it easy to exterminate. Another beetle is also easy to catch early. This beetle’s bright orange color makes it easy to spot on green leaves. This allows farmers to catch an infestation before it spreads too far.

Many farmers have an ongoing struggle with controlling beetle populations in their crops. It is easy to tell when the spinach beetle has infested a crop. This beetle chews holes in spinach leaves. It is easily removed if discovered in time. The carrot beetle is also easy to catch early. This beetle’s bright orange color makes it easy to spot on green leaves. This allows farmers to catch an infestation before it spreads too far.

Many farmers have an ongoing struggle with controlling beetle populations in their crops. It is easy to tell when the spinach beetle has infested a crop. This beetle chews holes in spinach leaves. It is easily removed if discovered in time. Another beetle is also easy to catch early. This beetle’s bright orange color makes it easy to spot on green leaves. This allows farmers to catch an infestation before it spreads too far.

Many farmers have an ongoing struggle with controlling beetle populations in their crops. It is easy to tell when the spinach beetle has infested a crop. This beetle chews holes in spinach leaves. It is easily removed if discovered in time. The carrot beetle is also easy to catch early. This beetle eats young carrot plants. The damage is easy to see. This allows farmers to catch an infestation before it spreads too far.
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Many farmers have an ongoing struggle with controlling beetle populations in their crops. It is easy to tell when the lemon beetle has infested a crop. It’s shiny yellow shell is a dead giveaway. This makes it easy to exterminate. The carrot beetle is also easy to catch early. This beetle eats young carrot plants. The damage is easy to see. This allows farmers to catch an infestation before it spreads too far.

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APPENDIX G
FULL SET OF FILLER PASSAGES FOR EXPERIMENT 2

Gabriel was studying different methods of cloth making. Different methods would yield different surface textures. Gabriel's favorite cloth was beetle linen. This cloth had a stiff shiny surface that looked like a beetle's shell. The process of pounding the cloth with wooden mallets was time consuming but the finished product was quite stunning.

Most pine trees are famous for their soft, straight, timber. However, many types of pine trees also provide products other than wood. The sap of the pitch pine yields turpentine and wood tar. The pinon pine grows primarily in the American Southwest. This short pine produces the edible seeds commonly known as pine nuts.

Some trees are easily distinguishable by their bark. The plane tree's bark comes off in chunks so that the tree has a spotted look with the lighter bark beneath showing through the dark outer bark. One tree with unique bark is the tulip tree. Its bark is a pale yellow, resembling a tulip. The tulip tree is native to Southern Africa.

Water was a precious commodity for early explorers. When water was found upon landing, the crews did the best they could to preserve it. As a result, people found substitute liquids to cook with. The cow tree was always a welcome sight to explorers. They could use its juice in place of milk in many of their recipes, allowing them to conserve water.

Bird feeders are a fun spring project. Young children can keep a journal of which birds they see. Some birds are easier to identify than others. The red poll finch has a red patch on its head and a black chin. The chickadee, on the other hand, has a little black cap on its head. These two birds are favorites of children, perhaps because they are able to identify them on their own.

Jeffrey was developing an interest in fishing. He watched television shows about deep sea fishing all the time. One of his favorite episodes was when the boat Ahab's Revenge caught a rabbit fish. The head and teeth of this large fish resemble a rabbit. Jeffrey was amazed at some of the creatures that get pulled up from the depths.

Many lizards have the ability to change colors. Perhaps the most famous is the chameleon which can change color to match its surroundings. Many other lizards change color during mating season. The fence lizard is usually a drab, brown color. However, during courtship it develops a bright blue belly and throat to attract females.

Finches make very good pet birds. They are small, easy to care for, and many of them have beautiful marking. The purple finch adds a dash of color to any room. The zebra finch is a popular choice as well. It has stripes on the side of its head and a bright red beak. Finches are very vocal birds. They are constantly chattering in their cages.

Many animals have developed unique ways of capturing their prey. Some are straightforward hunters. Others rely on tricks. The angler fish is quite a trickster. It has a long fin on its back with a small appendage that resembles a worm on a fishing pole. It uses this fin to lure smaller fish close enough that it can capture them.

Jessica was doing a project on birds' methods of camouflaging themselves. She had a number of photographs of birds that change their coloring depending on the season. One clear example was the snowy bunting. This bird has brown feathers in the summer. In the winter, the brown edges get rubbed off and the feathers become snowy white, allowing the bird to camouflage itself quite well.

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Driving through farmland, one often sees the cattle egret standing in pastures. This tall white bird follows cattle around, eating the insects that they kick up as they walk. The birds long legs allow it to wade through wet muddy areas that smaller birds cannot walk through. This gives the egret a distinct advantage.

Jennifer was cleaning out her closet. She had a pile of clothes to be given to the local homeless shelter. She also had a pile to keep. In order to keep things somewhat organized she folded all her winter clothes and put them in the sweater chest. Then she put the clothes to give away into garbage bags and took them out to her car. Finally, she hung everything else back in the closet.

The Aztecs were one of the most advanced of ancient civilizations. They understood how to keep track of the solar year. They carved large calendar stones on which they marked off the days and their ritual festivals. Like modern civilizations, the Aztec calendar had 365 days.

Windsurfing has become a very popular sport in recent years. It is very physically demanding but technique and skill can be equally important. The surfer stands on the sail board and steers by changing the sail's position relative to the wind direction. The sail often falls but it is relatively easy to get it back up.

A number of different processes go into wine making. Once the grapes are harvested, they are crushed and the juice is put into large wine vats to ferment. The vats are made of oak so the wood adds flavor to the wine as it ages. The wine stays in the vats for different amounts of time depending on the type and age of the wine desired.

Swallows are some of the most creative birds when it comes to nesting. Cliff swallows build nests of mud pellets under ledges of cliffs or under eaves of houses. Chimney swifts build similar nests and attach them inside chimneys. The only opening is a small round hole near the top through which they can feed their young.

Falcons are some of the best hunters among the birds. Their keen eyesight and swift swooping abilities allow them to strike practically without warning. They are generally strong birds so they can carry even small animals as prey. The pygmy falcon has a bit more trouble carrying large prey. Its small size is an advantage, though, as it can fly for longer periods of time.

Mushroom lovers enjoy eating different kinds of exotic mushrooms. Many people go mushroom hunting themselves and come back with rare kinds. Some varieties, though, are poisonous and it can be difficult to tell them apart. The button mushroom is difficult to distinguish from many poisonous types. Therefore, people should only eat mushrooms that they can positively identify.

Jerry was mowing the lawn one day when he spotted a large ground growth on the lawn. He bent over to look at it and realized that it was a puffball mushroom that had grown to be almost a foot wide. He poked it and it collapsed, sending a cloud of spores into the air. Jerry knew that next year he would be finding many more mushrooms in his lawn.

Many mosses regenerate by producing spores rather than seeds. Club mosses look like little pine trees. They have cones at the tips of their branches. Pine cones have seeds in them that allow the trees to spread but the club moss cones have spores instead of seeds. Because they regenerate this way, many mosses form in dense patches before spreading.

Bryce and Molly were out in the backyard gathering fiddlehead ferns for supper. Their mother had told them not to pick any that were too old because they would be tough and bitter. Therefore, Bryce was showing Molly a fern that looked just like the end of a violin. It hadn't begun to uncurl at all. Bryce said this was a perfect example of a fiddlehead fern.
Tara came running inside and asked her mother why the rabbit in the backyard didn’t have a white tail like the one in her favorite storybook. Tara’s mother explained that only cottontail rabbits have the little white tails. They went upstairs and looked at a book so Tara could see examples of other kinds of rabbits. When they were done, Tara asked if she could have a bunny for a pet.

Ants often depend on other creatures for their own survival. Amazon ants cannot do anything for themselves. They invade other colonies and capture slaves to work for them. Honey ants feed on the honeydew secreted by aphids. Neither of these ants could survive without the species that they depend on.

In the spring, the deserts burst into bloom. Brown and dry most of the year, the deserts suddenly come alive with bright flowers. Pink, red and yellow flowers appear all over. The barrel cactus, a short round cactus, is crowned by a ring of bright red flowers. This is one of the best times of year to visit the desert as it is also relatively cool.
APPENDIX H
FULL SENTENCE READING TIME ANALYSES: FIRST PASS

First Pass (Subject Means)
Raw Times

<table>
<thead>
<tr>
<th>Condition</th>
<th>Critical Sentence 1</th>
<th>Critical Sentence 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: dominant/parallel dimension</td>
<td>3970</td>
<td>3809</td>
</tr>
<tr>
<td>2: condition 1 control</td>
<td>4097</td>
<td>3736</td>
</tr>
<tr>
<td>3: dominant/new dimension</td>
<td>4094</td>
<td>3791</td>
</tr>
<tr>
<td>4: condition 3 control</td>
<td>3945</td>
<td>4056</td>
</tr>
<tr>
<td>5: non-dominant/parallel dimension</td>
<td>4252</td>
<td>4001</td>
</tr>
<tr>
<td>6: condition 5 control</td>
<td>3958</td>
<td>3692</td>
</tr>
<tr>
<td>7: non-dominant/new dimension</td>
<td>4093</td>
<td>4040</td>
</tr>
<tr>
<td>8: condition 7 control</td>
<td>3839</td>
<td>3743</td>
</tr>
</tbody>
</table>

F Values for First Pass Times: Full Sentence Analyses
Subjects (Items)

<table>
<thead>
<tr>
<th></th>
<th>Critical Sentence 1</th>
<th>Critical Sentence 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td>.007 (.28)</td>
<td>.04 (.15)</td>
</tr>
<tr>
<td>Dimension</td>
<td>.59 (.04)</td>
<td>.93 (1.44)</td>
</tr>
<tr>
<td>Control</td>
<td>.88 (1.24)</td>
<td>1.34 (.34)</td>
</tr>
<tr>
<td>Dominance x Dimension</td>
<td>.34 (.007)</td>
<td>.43 (.01)</td>
</tr>
<tr>
<td>Dominance x Control</td>
<td>2.19 (2.53)</td>
<td>5.08* (3.16 p = .09)</td>
</tr>
<tr>
<td>Dimension x Control</td>
<td>.19 (.30)</td>
<td>.61 (.57)</td>
</tr>
<tr>
<td>Dominance x Dimension x Control</td>
<td>.53 (.50)</td>
<td>.79 (1.05)</td>
</tr>
</tbody>
</table>

* p < .05
APPENDIX I
INITIAL ANALYSES OF CRITICAL REGIONS: FIRST PASS

First Pass (Subject Means)
MS/Char (raw)

<table>
<thead>
<tr>
<th>Condition</th>
<th>C1</th>
<th>D1</th>
<th>C2</th>
<th>D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: dominant/parallel dimension</td>
<td>44.75 (596)</td>
<td>36.50 (624)</td>
<td>45.50 (615)</td>
<td>34.55 (594)</td>
</tr>
<tr>
<td>2: condition 1 control</td>
<td>46.48 (611)</td>
<td>37.58 (669)</td>
<td>31.04 (462)</td>
<td>40.15 (694)</td>
</tr>
<tr>
<td>3: dominant/new dimension</td>
<td>42.22 (546)</td>
<td>37.10 (684)</td>
<td>38.79 (512)</td>
<td>37.25 (601)</td>
</tr>
<tr>
<td>4: condition 3 control</td>
<td>48.53 (644)</td>
<td>37.53 (683)</td>
<td>33.84 (507)</td>
<td>36.83 (555)</td>
</tr>
<tr>
<td>5: non-dominant/parallel dimension</td>
<td>42.77 (574)</td>
<td>40.69 (764)</td>
<td>41.34 (522)</td>
<td>41.27 (688)</td>
</tr>
<tr>
<td>6: condition 5 control</td>
<td>46.15 (647)</td>
<td>41.19 (780)</td>
<td>36.52 (551)</td>
<td>42.55 (769)</td>
</tr>
<tr>
<td>7: non-dominant/new dimension</td>
<td>43.98 (581)</td>
<td>34.83 (623)</td>
<td>44.97 (557)</td>
<td>43.15 (742)</td>
</tr>
<tr>
<td>8: condition 7 control</td>
<td>41.33 (557)</td>
<td>37.71 (651)</td>
<td>34.25 (516)</td>
<td>41.95 (757)</td>
</tr>
</tbody>
</table>

F Values for First Pass Times: Initial Analyses
Subjects (Items)

<table>
<thead>
<tr>
<th></th>
<th>C1</th>
<th>D1</th>
<th>C2</th>
<th>D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td>1.18 (.38)</td>
<td>.86 (6.11*)</td>
<td>2.10 (1.64)</td>
<td>13.75*** (4.16*)</td>
</tr>
<tr>
<td>Dimension</td>
<td>.33 (1.09)</td>
<td>1.81 (2.86)</td>
<td>.23 (1.54)</td>
<td>.01 (.35)</td>
</tr>
<tr>
<td>Control</td>
<td>1.27 (1.14)</td>
<td>.78 (.20)</td>
<td>47.21*** (10.67**)</td>
<td>.86 (1.09)</td>
</tr>
<tr>
<td>Dominance x Dimension</td>
<td>.19 (.51)</td>
<td>3.74 (.59)</td>
<td>1.09 (.37)</td>
<td>.07 (.06)</td>
</tr>
<tr>
<td>Dominance x Control</td>
<td>1.48 (3.62)</td>
<td>.11 (.32)</td>
<td>.72 (2.38)</td>
<td>.61 (.002)</td>
</tr>
<tr>
<td>Dimension x Control</td>
<td>.03 (.01)</td>
<td>.07 (.14)</td>
<td>.47 (.49)</td>
<td>2.19 (1.40)</td>
</tr>
<tr>
<td>Dominance x Dimension x Control</td>
<td>2.64 (1.07)</td>
<td>.44 (.96)</td>
<td>9.78** (2.50)</td>
<td>.37 (.70)</td>
</tr>
</tbody>
</table>

*** p < .001
** p < .01
* p < .05
APPENDIX J
SELECTED ITEMS ANALYSES: FIRST PASS

F Values for First Pass Times
Subjects (Items)

<table>
<thead>
<tr>
<th></th>
<th>C1</th>
<th>D1</th>
<th>C2</th>
<th>D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominance</td>
<td>2.14 (.55)</td>
<td>.86 (6.79)*</td>
<td>.86 (.11)</td>
<td>9.93** (1.44)</td>
</tr>
<tr>
<td>Dimension</td>
<td>1.25 (2.29)</td>
<td>4.57* (1.32)</td>
<td>1.93 (2.05)</td>
<td>.01 (.07)</td>
</tr>
<tr>
<td>Control</td>
<td>1.63 (3.17)</td>
<td>.22 (.38)</td>
<td>30.28*** (6.75*)</td>
<td>.03 (2.31)</td>
</tr>
<tr>
<td>Dominance x Dimension</td>
<td>.008 (.60)</td>
<td>6.07* (1.27)</td>
<td>3.06 (.32)</td>
<td>.09 (.08)</td>
</tr>
<tr>
<td>Dominance x Control</td>
<td>.24 (.54)</td>
<td>.67 (.19)</td>
<td>.10 (2.20)</td>
<td>2.74 (1.55)</td>
</tr>
<tr>
<td>Dimension x Control</td>
<td>.05 (.09)</td>
<td>.22 (.008)</td>
<td>1.21 (2.54)</td>
<td>2.94 (.66)</td>
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<tr>
<td>Dominance x Dimension x Control</td>
<td>3.30 (1.24)</td>
<td>.007 (.03)</td>
<td>7.29** (6.17*)</td>
<td>.00 (.28)</td>
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*** p < .001
** p < .01
* p < .05
APPENDIX K
INITIAL AND SELECTED ITEMS ANALYSES: TOTAL TIME

Initial Analyses: Total Time (Subject Means)
MS/Char

<table>
<thead>
<tr>
<th>Condition</th>
<th>C1</th>
<th>D1</th>
<th>C2</th>
<th>D2</th>
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</thead>
<tbody>
<tr>
<td>1: dominant/ parallel dimension</td>
<td>57.08</td>
<td>44.08</td>
<td>51.04</td>
<td>43.40</td>
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<tr>
<td>2: condition 1 control</td>
<td>54.51</td>
<td>43.05</td>
<td>38.56</td>
<td>47.14</td>
</tr>
<tr>
<td>3: dominant/ new dimension</td>
<td>53.87</td>
<td>47.03</td>
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</tr>
<tr>
<td>4: condition 3 control</td>
<td>59.03</td>
<td>46.38</td>
<td>44.67</td>
<td>45.44</td>
</tr>
<tr>
<td>5: non-dominant/ parallel dimension</td>
<td>54.55</td>
<td>50.63</td>
<td>48.73</td>
<td>47.85</td>
</tr>
<tr>
<td>6: condition 5 control</td>
<td>54.53</td>
<td>45.43</td>
<td>41.75</td>
<td>56.81</td>
</tr>
<tr>
<td>7: non-dominant/ new dimension</td>
<td>56.83</td>
<td>40.23</td>
<td>53.00</td>
<td>50.40</td>
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<tr>
<td>8: condition 7 control</td>
<td>49.74</td>
<td>45.81</td>
<td>41.47</td>
<td>51.04</td>
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</table>

Selected Items Analyses: Total Time (Subject Means)
MS/Char

<table>
<thead>
<tr>
<th>Condition</th>
<th>C1</th>
<th>D1</th>
<th>C2</th>
<th>D2</th>
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</thead>
<tbody>
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<td>1: dominant/ parallel dimension</td>
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<td>41.61</td>
<td>50.77</td>
<td>39.02</td>
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<tr>
<td>2: condition 1 control</td>
<td>54.19</td>
<td>42.04</td>
<td>37.11</td>
<td>45.82</td>
</tr>
<tr>
<td>3: dominant/ new dimension</td>
<td>53.31</td>
<td>45.60</td>
<td>52.10</td>
<td>43.19</td>
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<td>4: condition 3 control</td>
<td>58.90</td>
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<td>54.04</td>
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<tr>
<td>7: non-dominant/ new dimension</td>
<td>59.84</td>
<td>40.68</td>
<td>52.46</td>
<td>51.71</td>
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<tr>
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<td>47.77</td>
<td>41.37</td>
<td>38.89</td>
<td>47.15</td>
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</tbody>
</table>
### APPENDIX L

**DOMINANT CONDITIONS ANALYSES: ALL MEASURES**

#### F Values for First Pass Times: Dominant Conditions Only

<table>
<thead>
<tr>
<th>Subjects (Items)</th>
<th>C1</th>
<th>D1</th>
<th>C2</th>
<th>D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
<td>.73 (.41)</td>
<td>.002 (.22)</td>
<td>4.89* (1.87)</td>
<td>.01 (.18)</td>
</tr>
<tr>
<td>Control</td>
<td>1.58 (4.98)*</td>
<td>.79 (.64)</td>
<td>20.46*** (27.38)**</td>
<td>1.74 (2.94)</td>
</tr>
<tr>
<td>Dimension x Control</td>
<td>1.47 (2.32)</td>
<td>.16 (.02)</td>
<td>9.25** (11.91)**</td>
<td>1.46 (1.35)</td>
</tr>
</tbody>
</table>

*** p < .001  
** p < .01  
* p < .05

#### F Values for Total Times: Dominant Conditions Only

<table>
<thead>
<tr>
<th>Subjects (Items)</th>
<th>C1</th>
<th>D1</th>
<th>C2</th>
<th>D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
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<td>2.11 (4.27)</td>
<td>.15 (.27)</td>
</tr>
<tr>
<td>Control</td>
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<td>.09 (.006)</td>
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<td>1.54 (4.25)</td>
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<td>1.35 (2.95)</td>
<td>.02 (.003)</td>
<td>.73 (1.17)</td>
<td>1.25 (.39)</td>
</tr>
</tbody>
</table>

*** p < .001  
** p < .01  
* p < .05

#### F Values for Second Pass Times: Dominant Conditions Only

<table>
<thead>
<tr>
<th>Subjects (Items)</th>
<th>C1</th>
<th>D1</th>
<th>C2</th>
<th>D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
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<td>2.16 (4.32)</td>
<td>6.99 * (11.24 **)</td>
<td>1.12 (.32)</td>
</tr>
<tr>
<td>Control</td>
<td>.02 (.36)</td>
<td>.27 (.41)</td>
<td>.28 (.01)</td>
<td>.05 (.45)</td>
</tr>
<tr>
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<td>.15 (.33)</td>
<td>.65 (.19)</td>
<td>.18 (.64)</td>
<td>.008 (.82)</td>
</tr>
</tbody>
</table>

*** p < .001  
** p < .01  
* p < .05


