Imagery and the Interpretation of Ambiguous Noun-Noun Combinations

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Imagery and the Interpretation of Ambiguous Noun-Noun Combinations

James A. Hampton, Dyonne Francis and George Robson

City University, London UK

Corresponding author:

James A. Hampton

Department of Psychology, City University, Northampton Square

London, EC1V OHB, UK

(+44 20 7040 8520: Fax 8581) Email: hampton@city.ac.uk

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Running Head: Imagery and Conceptual Combination
Abstract

Novel N-N combinations such as *cheetah truck* were created that had two alternative interpretations, one based on a thematic relation (*a truck for transporting cheetahs*), and one using a property mapping (*a fast truck*). Experiment 1 asked people to generate their own interpretations, which were classified as involving thematic relations, property mapping or other. Experiment 2 asked people to choose which of the two interpretations was most plausible. Both Experiments showed that instructions to work rapidly through the task led to more thematic relational interpretations, whereas instructions to visualize and reflect more deeply on the problem led to more property mapping. Implications for models of conceptual combination are discussed.
Hampton, Francis & Robson

Imagery and the Interpretation of Ambiguous Noun-Noun Combinations

A number of languages, such as English, Dutch and German, include a mechanism for constructing novel noun phrases by concatenating bare nouns. There already exist many such N-N combinations (for example fire truck or steam train), but the mechanism is productive and also allows the construction of indefinitely many novel noun phrases (for example steam truck or fire train). The mechanisms by which such phrases can be allocated an interpretation have been extensively studied in recent years (see Hampton, 1997; Murphy, 2002, Ch. 12 for reviews). For example, Wisniewski (1996, 1997) collected a large database of people’s free interpretations of novel combinations. From a qualitative analysis of the data, three main categories of interpretation emerged, each with parallels among more familiar noun phrases. Thematic relation or relation-linking interpretations involve the interposition of a semantic relation between the two nouns. The second noun is taken as the head noun (that is it determines the broad referential class of the combination) and the first noun identifies a subset of that class through some additional semantic constraint. For example a robin snake could be interpreted as a kind of snake that primarily feeds on robins. Here the semantic relation “feeds on” has to be added to the two simple concepts in order to provide the interpretation. Note that there may be indefinitely many such relations that could be found for any particular combination, and that elaborate story contexts can make even the most bizarre interpretation acceptable (Gerrig & Murphy, 1992).

The second category of interpretation described by Wisniewski involved property mapping, by which a salient property of the first (modifier) noun is used to modify the second (head) noun. In the case of a robin snake an alternative interpretation using property mapping
Hampton, Francis & Robson Imagery and conceptual combination. 4

would take a salient feature of robins – such as their red breasts – and map this to the head noun concept snake, thus giving the interpretation of a kind of snake with a red patch on its breast.

The success of such interpretations has been shown to depend on two important factors. First the modifier noun should have a well-known and distinctive property – robins should be known for having red breasts. Second, the head noun should have a dimension that can be readily modified by this property. In the case of snakes, this could be problematic since it is not clear in what sense a snake has a breast (Costello & Keane, 2001; Estes & Glucksberg, 2000).

The third kind of interpretation, that will not concern us in this paper, is hybridization – where a novel concept is created that belongs (at least to some extent) in both categories. This type of interpretation was generally quite rare in Wisniewski’s database.

Models of N-N Combination

Several distinct models have emerged for the explanation of N-N combinations (Gagné, 2000; Murphy, 1990; Wisniewski & Love, 1998). Gagné’s CARIN model proposes a single process that incorporates both the thematic relation and the property mapping forms of combination. Following pioneering work by Levi (1978), CARIN proposes that only a limited number of fairly general semantic relations are used in the large majority of cases – relations such as USED FOR, MADE OF or FOUND IN. A key element of the model is that selection of the appropriate relation is driven by the past history of combinations using the particular modifier involved. Thus Gagné & Shoben (1997) showed that people were fastest to accept interpretations that used a relation that was of high frequency for the modifier, whereas frequency of a relation for the head noun did not influence processing speed. Should it prove hard to find a suitable relation (as may occur with some novel combinations) then a relation IS
SIMILAR TO may be employed, together with the retrieval of a suitable property that can be mapped from the modifier to the head noun. The property mapping interpretation of *cheetah truck* as “a fast truck” would therefore be generated within CARIN as using a thematic relation such as “IS SIMILAR TO A CHEETAH IN RESPECT OF SPEED”. Because more specific thematic relations are searched first, the model predicts that property mapping will be used relatively infrequently, and should take longer to generate, predictions borne out by Gagné (2002).

The major competitor to CARIN is a proposal by Wisniewski and Love (1998) for a dual processing system. According to this proposal, relations and properties are two independent strategies that may be employed for interpreting N-N combinations. In support of this idea, Wisniewski and Love showed that the interpretation of ambiguous combinations such as *spear chisel* or *ant vegetable* could be influenced by priming with 10 combinations that could only be interpreted with either one or the other strategy. They therefore argued that both interpretation strategies are available, and that consequently there may be two independent ways in which an interpretation is sought for a novel combination (for priming of interpretations see also Estes, 2003; Gagné & Shoben, 2002, for a critical analysis of the empirical basis of CARIN see Wisniewski & Murphy, 2005).

The aim of our studies was to examine whether differential use of the two interpretation strategies would be found as a function of processing demands. If, as CARIN would predict, property interpretations are used only as a “last resort” when no other thematic interpretation suggests itself, then whenever a reasonable thematic interpretation is available, it should be the preferred interpretation. It should not matter whether participants are working with or without
time pressure, or with or without instructions to imagine the items – the thematic interpretation should normally be preferred.

On the other hand, if there are two processes of interpretation involved, manipulation of the instructions may influence which interpretation is arrived at. If relational interpretations are quicker and easier to generate whereas property interpretations take longer (as is suggested by Gagné, 2002), then requiring participants to answer as quickly as possible should favor the relational interpretation of an ambiguous combination. On the other hand, instructions to retrieve and visualize the meanings of the nouns and to reflect carefully on the best interpretation may bias the interpretation in the direction of property interpretations (Wisniewski & Middleton, 2002).

Visualization may be particularly important for the generation of property interpretations because a successful property mapping requires the retrieval of specific information about each concept. A thematic relation can be fairly unconstrained by the meaning of the modifier (e.g. a chocolate box, a horse box and a pencil box may all use the CONTAINS relation, regardless of the large semantic differences between chocolates horses and pencils). On the other hand a property relation requires use of the salient property of the modifier, which requires that the meaning of the modifier must first be retrieved in sufficient detail.

Accordingly we conducted two studies in which ambiguous N-N combinations were given to people to interpret, either under time pressure, or with instructions to respond carefully and after due reflection with visualization of the concepts involved. We argue that CARIN should predict no effect of this manipulation on the level of relation versus property interpretations generated, since if a relational interpretation is available it should always be
selected first.

The dual process model would agree with the prediction that relation interpretations will be more likely to be generated when under time pressure, since property interpretations require more detailed retrieval of meanings. For the slow visualization condition however, the dual process model makes no clear prediction, although a switch in preference with condition would clearly be more compatible with the dual process framework.

Experiment 1

In the first study, participants were presented with N-N pairs and asked to generate their own interpretations. Half performed the task under time pressure, and half were asked to imagine the object first. Proportions of relation and property interpretations were calculated.

Method.

Participants. Forty undergraduate students at City University, London participated for credit. All had English as a first language.

Materials. Property interpretations require a salient modifier property that is relevant to the head noun (Estes & Glucksberg, 2000). In order to generate suitable materials, 30 dimensional adjectives were used in an analogy task that was given to 10 participants to complete. For example participants had to complete phrases such as “as strong as a _____”. The resulting responses were combined with head nouns in order to construct ambiguous N-N combinations such as ox rope, which has either the interpretation “a strong rope” or “a rope for use with oxen”. Other materials were selected from previous research to generate a total of 25 N-N pairs. The Appendix lists the materials used.

Design and Procedure. Participants were randomly allocated to one of two conditions (20
Hampton, Francis & Robson

Imagery and conceptual combination.  8

per condition), and instructions were manipulated between the two. For the Shallow condition, the following instructions were given:

“On the following pages you will find pairs of words. Please think of the first meaning for the phrase that comes to mind. Work as fast as you can through the list. Some phrases may be ambiguous but it is the first meaning you think of that you should give. Please write this meaning in the space next to each pair.”

For the Deep condition, the instructions were instead:

“On the following pages you will find pairs of words. Please read each word very carefully and try to form an image of what kind of thing it may be referring to. Then write a meaning in the space provided that best explains the phrase. Some phrases may be ambiguous but it is the meaning that on consideration you believe best that you should give.”

In order to encourage participants to use both possible interpretation strategies, four unambiguous N-N combinations were used as warm-up items at the start of the list, two with unambiguous property interpretations (e.g. razor insult), and two with unambiguous relation interpretations (e.g. grocery bicycle). Two different random list orders were used.

Results and Discussion

Responses were judged by two independent judges, one of whom was blind to the aims of the study. Each response was categorized as Relation, Property or Other. Judges agreed on the classification of 85% of all responses, and disagreements were resolved by discussion.

Responses categorized as Other were removed from further analysis. Table 1 shows the mean (and standard deviation) number of interpretations (out of 25) that were categorized as Property
or Relation in each condition. (Because 18-29% of responses were rejected as Other, the number of interpretations of each type was relatively free to vary independently).

**INSERT TABLE 1 ABOUT HERE**

Table 1 shows a clear cross-over interaction in the preference for a relation or property interpretation as a function of condition. In the Shallow condition, relations were used more often than properties, whereas in the Deep condition the pattern was reversed. ANOVA was run with condition and interpretation type as factors, and with either participants or items as random effects. Neither main effect was significant in either analysis, but the interaction was highly significant in both (Min F’(1,56) = 31.1, p < .001).

As expected by CARIN, relations were the preferred interpretation in the Shallow condition, consistent with a strategy that considers relations first. However CARIN would not predict the switch to property interpretation in the Deep condition. While not predicting the cross-over interaction, the dual process approach could accommodate this result. It would propose that in the slow visualization condition the property interpretation generates a more satisfying interpretation than the relational interpretation. Because the meaning of the modifier is retrieved more fully and a fit found to a dimension of the head, participants may have found the resulting interpretation pragmatically more relevant than the relation interpretation.

In order to confirm the generality of our results, Experiment 2 used a different dependent measure, and extended the number of conditions to include a neutral control condition, to test the role of imagery in our instructions.

**Experiment 2**

Experiment 1 asked participants to generate their own responses. In Experiment 2 we
instead presented people with two alternative interpretations and asked them to choose the one that they thought the more plausible. If the effect found in Experiment 1 primarily reflects the process of *generating* an interpretation, it is possible that there will be no effect of instructions on the choice between two offered interpretations. Alternatively if the effect is also found in a choice task, it would imply that the switch between the two strategies is more general and applies to both the generation, and the comprehension, of interpretations.

It is unclear why a single process model such as CARIN would predict any difference in the selection of a property or a relation interpretation as more plausible as a function of time pressure or imagery instructions. On the other hand, if understanding property interpretations is more cognitively demanding, we expect that time pressure will lead to people preferring the relational interpretations, whereas without time pressure they may show no preference. If in addition the instruction to form images leads to discovery of the salient property of the modifier noun, then in the Imagery condition a preference should be expressed for the property interpretation. In order to test whether it was time pressure or imagery (or both) that led to the shift in strategy, Experiment 2 included a third Control condition in which there was no requirement to respond quickly, and likewise no instruction to form images of the entities described. If it was time pressure that primarily led to the preference for thematic interpretations, then the Control condition should pattern like the Deep (Imagery) condition. On the other hand if forming images was the key difference between conditions in Experiment 1, the Control condition should pattern like the Shallow condition.

**Method**

*Participants.* Forty-eight students at universities in London participated without reward.
Four were discarded because they failed to comply with instructions. One additional participant was recruited in order to rebalance the design.

**Materials.** A new set of materials was constructed using the same method as before. In addition, 3 different modifier nouns were selected for each head noun, all with the same property and relation interpretations. For example red colored wallpaper, or wallpaper with a pattern depicting a fruit was represented with the three pairs *Cherry wallpaper, Raspberry wallpaper* and *Strawberry wallpaper*. One of each of these pairs was allocated to each of the three conditions, so that three lists of 22 items each were created. A full list of materials is shown in the Appendix.

**Design and Procedure.** Three conditions were used, varying only in the instructions provided at the start. All participants contributed to each condition. Booklets were constructed with three sections, each with a different instructional condition. Each section contained one of the lists of N-N combinations, so that for example section A would contain *cherry wallpaper*, section B *raspberry wallpaper*, and section C *strawberry wallpaper*. Allocation of list to the three conditions was fully rotated across booklets. Order of the three conditions within booklets was also fully balanced across participants. Each section of the booklet began with an instruction sheet as follows:

- **Shallow condition:** “Please read and complete as fast as you can, you have 4 minutes in total”
- **Control condition:** “There is no time limit, please read and choose the most plausible interpretation”
- **Imagery condition:** “Please take your time and form an image of each noun before you choose the most plausible interpretation. For example for encyclopedia writer imagine an
encyclopedia and imagine a writer and then select your answer.”

Each section of the booklet contained the list of 22 items with a 1-5 scale for recording judgments. The scale was printed underneath the two interpretations. The scale ratings 1-2 and 4-5 indicated that either the left or the right interpretation was more plausible, and the middle value of 3 meant that the two interpretations were equally plausible. Half the property interpretations were placed on the left and half on the right, and order was randomized within each list.

Results

Participants expressed a preference for one or other of the interpretations on 86% of trials, and this value did not change significantly with condition. Mean scale values were calculated for each participant and each item under each of the three instructional conditions. Table 2 shows the results. A preference for the relation interpretation was scored as a low number and a preference for the property interpretation was scored as a higher number while 3 was the centre of the scale.

Neither the Shallow nor the Control conditions showed any significant preference for the relation or the property interpretations (means were not significantly different from 3), and nor did they differ significantly from each other. However the Imagery condition showed a significant preference for the property mapping interpretation (one sample t(44) = 4.1, p < .001). Repeated measures ANOVA by subjects and by items showed a significant effect of Condition (Min F’ (2, 131) = 6.81, p < .005), and post hoc comparisons confirmed that the mean rating for the Imagery condition was significantly greater than the other two conditions,
For Review Only

Hampton, Francis & Robson

(t(44) = 3.28 and 3.85 for the comparison with the Control and the Shallow respectively, both p < .005), which did not differ from each other (t(44) = 1.04, p > .10). Overall, 19 of the 22 sets, and 32 of the 45 participants had the highest mean rating in the Imagery condition.

Discussion

Experiment 2 tested the generality of the findings from Experiment 1 by asking participants to select one of two interpretations for an ambiguous N-N phrase, rather than to generate their own. The results were broadly in line with the earlier effect. When asked to form images of the concepts involved there was a greater preference for property interpretations, compared with either a speeded judgment or a standard condition with neutral instructions. It would appear therefore that the key factor differentiating the conditions in Experiment 1 was not the time pressure but the imagery instructions.

The materials in the Appendix show that the property mapping interpretations tended to be shorter than the relational interpretations. A property mapping can often be captured by a single adjective (“a tall tree”) whereas relational interpretations require the relation to be spelled out at greater length. It is noteworthy that in spite of the shorter time needed to read the property mapping interpretations it was in the deeper Imagery condition that they were preferred. The results could not therefore be explained by differences in length of the interpretations offered.

Unlike Experiment 1, there was no clear preference for relation interpretations in the Shallow and Control conditions. Given that the relation interpretations were plausible (pig house = a house for pigs), CARIN would have predicted that they would be the interpretation that was most easily arrived at. Note however that the materials for Experiment 2 were different.
from those in the earlier experiment. Note also that when the interpretations are given to the
participant to read, different processes are most likely invoked in judging which is to be
preferred. We hypothesize that the two interpretations were well balanced in the default case of
the Control and Shallow conditions, but that instructions to visualize the concepts led to a bias
towards the property interpretation for reasons similar to the preference for generating property
interpretations in Experiment 1. The shorter length of the property interpretations may also
biased participants towards them in the Shallow condition where speedy judgments were
required.

The size of the effect in Experiment 2 was much smaller than in the first experiment
where participants generated their own interpretations. This difference could be expected, given
that a production task is likely to place a heavier cognitive load on the participant, and so be
more sensitive to instructions. Given the smaller effect size, Experiment 2 was less powerful to
detect differences between the Shallow and Control conditions. There was a trend for the
Shallow condition to lead to a greater preference for the relation interpretations compared to the
Control condition, and it is possible that a more powerful design would show this to be a real
difference.

General Discussion

Two accounts of conceptual combination for N-N combinations have been compared.
The CARIN model (Gagné, 2002) argues for a single process based on the retrieval and
confirmation of an appropriate thematic relation. Only when a relation fails to be retrieved may
people then turn to property interpretations, under the general relation of IS LIKE.
Alternatively, Wisniewski and others have argued that property interpretations are generated by
a separate independent process.

The results of our experiments favor the second of these two accounts. Given that under
time pressure people are able to generate and choose relational interpretations just as readily as
property interpretations, it is not clear why they should show a marked preference for
generating and selecting property interpretations rather than relation interpretations in the Deep
Imagery conditions.

Generating and comprehending property interpretations for N-N combinations appears to
be a more effortful process. Whereas the relations involved in thematic relation interpretations
are often quite general (for example CARIN proposes a limited set of about 10-12 such
relations), property mapping interpretations require more detailed information to be retrieved
about the modifier category. Experiment 1 showed that where a relation interpretation exists,
the “first meaning that comes to mind” is more often than not a relation. However when given
the time to consider the meaning of each noun in a more reflective mode, a strong preference
was shown for generating a property relation.

Our results place new constraints on models of how N-N phrases are interpreted. They
strongly suggest that strategic effects are involved (in keeping with earlier demonstrations of
priming effects on interpretation, Wisniewski & Love, 1998), and that a single process account
is unlikely to capture the full range of observable phenomena.
Author's Note

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References


Hampton, Francis & Robson Imagery and conceptual combination.


Appendix

1) Materials used in Experiment 1

**Unambiguous Fillers**

<table>
<thead>
<tr>
<th>Butcher Surgeon</th>
<th>Grocery Bicycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Razor Insult</td>
<td>Adultery Sermon</td>
</tr>
</tbody>
</table>

**Ambiguous Targets**

<table>
<thead>
<tr>
<th>Cheetah Train</th>
<th>House Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skyscraper Plant</td>
<td>Fossil Book</td>
</tr>
<tr>
<td>Ox Rope</td>
<td>Sheet Space</td>
</tr>
<tr>
<td>Fox Puzzle</td>
<td>Snail Cart</td>
</tr>
<tr>
<td>Mouse Teacher</td>
<td>Feather Purse</td>
</tr>
<tr>
<td>Oven Room</td>
<td>Pig Socks</td>
</tr>
<tr>
<td>Spider Chair</td>
<td>Porcupine Cushion</td>
</tr>
<tr>
<td>Book Magazine</td>
<td>Rock Head</td>
</tr>
<tr>
<td>Strawberry Box</td>
<td>Ice Foot</td>
</tr>
<tr>
<td>Mule Manager</td>
<td>Butterfly Girl</td>
</tr>
<tr>
<td>Ant Vegetable</td>
<td>Elephant Boat</td>
</tr>
<tr>
<td>Doughnut Table</td>
<td>Skunk Perfume</td>
</tr>
<tr>
<td>Zebra Jeep</td>
<td></td>
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</table>
2) Materials used in Experiment 2

<table>
<thead>
<tr>
<th>Modifier 1</th>
<th>Modifier 2</th>
<th>Modifier 3</th>
<th>Head</th>
<th>Relation Interpretation</th>
<th>Property Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>dung</td>
<td>skunk</td>
<td>trash</td>
<td>perfume</td>
<td>perfume used to cover dung odor</td>
<td>stinky perfume</td>
</tr>
<tr>
<td>tower</td>
<td>giraffe</td>
<td>skyscraper</td>
<td>tree</td>
<td>tree that looks like a tower</td>
<td>tall tree</td>
</tr>
<tr>
<td>frost</td>
<td>ice</td>
<td>snow</td>
<td>toe</td>
<td>toe covered by frost</td>
<td>cold toe</td>
</tr>
<tr>
<td>stick</td>
<td>sheet</td>
<td>paper</td>
<td>space</td>
<td>space for sticks</td>
<td>thin space</td>
</tr>
<tr>
<td>stove</td>
<td>fire</td>
<td>oven</td>
<td>room</td>
<td>room that the stove is in</td>
<td>hot room</td>
</tr>
<tr>
<td>pin</td>
<td>razor</td>
<td>knife</td>
<td>beak</td>
<td>bird’s beak shaped like a pin</td>
<td>sharp beak</td>
</tr>
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<td>kitten</td>
<td>baby</td>
<td>child</td>
<td>shelf</td>
<td>shelf holding kitten ornaments</td>
<td>weak shelf</td>
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<tr>
<td>iron</td>
<td>rock</td>
<td>steel</td>
<td>doughnut</td>
<td>iron shaped like a doughnut</td>
<td>hard doughnut</td>
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<td>leopard</td>
<td>zebra</td>
<td>tiger</td>
<td>socks</td>
<td>therapeutic socks used on leopards</td>
<td>yellow and black spotted socks</td>
</tr>
<tr>
<td>quill</td>
<td>feather</td>
<td>cotton</td>
<td>purse</td>
<td>purse that holds quills</td>
<td>light purse</td>
</tr>
<tr>
<td>cherry</td>
<td>strawberry</td>
<td>raspberry</td>
<td>wallpaper</td>
<td>wallpaper with a cherry pattern</td>
<td>red wallpaper</td>
</tr>
<tr>
<td>cheetah</td>
<td>rocket</td>
<td>bullet</td>
<td>truck</td>
<td>special truck for transporting cheetahs</td>
<td>fast truck</td>
</tr>
<tr>
<td>snail</td>
<td>sloth</td>
<td>turtle</td>
<td>train</td>
<td>a line of snails marching closely</td>
<td>slow train</td>
</tr>
<tr>
<td>fox</td>
<td>dingo</td>
<td>wolf</td>
<td>holiday</td>
<td>holiday watching wild foxes</td>
<td>wild holiday</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>------</td>
<td>---------</td>
<td>-----------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>book</td>
<td>block</td>
<td>slab</td>
<td>magazine</td>
<td>magazine about books</td>
<td>thick magazine</td>
</tr>
<tr>
<td>octopus</td>
<td>arachnid</td>
<td>spider</td>
<td>table</td>
<td>table serving octopus</td>
<td>table with eight legs</td>
</tr>
<tr>
<td>dinosaur</td>
<td>antique</td>
<td>fossil</td>
<td>scientist</td>
<td>scientist who studies dinosaurs</td>
<td>very old scientist</td>
</tr>
<tr>
<td>hedgehog</td>
<td>cactus</td>
<td>porcupine</td>
<td>cushion</td>
<td>cushion with hedgehog design</td>
<td>prickly cushion</td>
</tr>
<tr>
<td>mule</td>
<td>bull</td>
<td>donkey</td>
<td>manager</td>
<td>person who is in charge of mules at a zoo/fair</td>
<td>stubborn manager</td>
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<tr>
<td>peacock</td>
<td>flower</td>
<td>butterfly</td>
<td>dress</td>
<td>dress with peacocks on it</td>
<td>pretty dress</td>
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<td>pig</td>
<td>sow</td>
<td>hog</td>
<td>house</td>
<td>house for pigs</td>
<td>dirty house</td>
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<tr>
<td>mouse</td>
<td>rabbit</td>
<td>hare</td>
<td>teacher</td>
<td>person who teaches mice to perform at the circus</td>
<td>timid teacher</td>
</tr>
</tbody>
</table>
Table 1

*Frequency of Interpretations (Mean and SD) Generated in Experiment 1*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Thematic Relation</th>
<th>Property Mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow</td>
<td>12.6 (5.3)</td>
<td>8.0 (3.6)</td>
</tr>
<tr>
<td>Deep</td>
<td>3.4 (4.0)</td>
<td>14.4 (4.5)</td>
</tr>
</tbody>
</table>
Table 2

*Mean (and SD) Ratings of Preference in Experiment 2. Lower Values Indicate Preference for Thematic Relational Interpretations.*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow</td>
<td>2.86 (0.59)</td>
</tr>
<tr>
<td>Control</td>
<td>2.96 (0.52)</td>
</tr>
<tr>
<td>Deep/Imagery</td>
<td>3.31 (0.50)</td>
</tr>
</tbody>
</table>