How Many Rooms in an Octopus Apartment?
Effects of Prosody on Conceptual Combination

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Abstract

Previous theories of conceptual combination have failed to address the possible role of suprasegmental factors such as prosodic emphasis patterns. Here, we investigated the effect of emphasising the initial word (modifier emphasis), both words (dual emphasis), or the final word (head emphasis) on people's interpretations of novel noun-noun compounds (e.g., *octopus apartment*). We found that dual emphasis alone affects the frequency of production and speed of property- and relation-based interpretations. People produced more relation-based (e.g., an *octopus apartment* is where an octopus lives) than property-based (e.g., an *octopus apartment* has eight rooms) interpretations when compounds were presented with dual emphasis than in written form. Additionally, dual emphasis caused people to arrive at property-based interpretations more rapidly than relation-based interpretations. Findings are discussed with reference to existing theories of conceptual combination.

Introduction

Octopus apartment, *latte crowd* and *snail mail* are all examples of coined noun-noun compounds generally referred to as concept combinations. These novel combinations reflect a fundamental aspect of language generativity, accounting for between 30% and 60% of new terms in English (Cannon, 1987; McFedries, 2004). It often happens that such compounds survive to become permanent fixtures of the language and used everyday by the wider language community (e.g., *soccer mom*, *camera phone*). Others may only be used in one specific context and not become part of the language as a lexicalised term in its own right (e.g., *daisy cup* as "a cup with a daisy pattern on it"). With these phrases occurring everywhere from newspaper headlines to advertisements and novels, it is clear that they represent an important aspect of language use and growth.

Over the past 25 years, there has been a wealth of research into the comprehension of concept combinations, with a number of different theoretical positions proposed. Most recent research acknowledges that for any given novel compound there can be many possible interpretations (e.g., constraint theory, Costello & Keane, 2000; Competition Among Relations in Nominals: CARIN, Gagné & Shoben, 1997; Producing and Understanding Novel Compounds: PUNC, Lynott et al., 2004; concept specialisation, Murphy, 1990).

These theories generally hold that the conceptual combination process involves the manipulation of properties and relations between the head (first concept) and the modifier (second concept). For example, the PUNC model (Lynott et al, 2004) interprets the compound *cactus beetle* by moving the feature "has spikes" from the modifier to the head, giving rise to the property-based meaning "a beetle that has spikes". Alternatively, the relation "eats" can be placed between the constituent nouns to give rise to the relation-based meaning "a beetle that eats cacti" (e.g., Lynott, et al., 2004; Gagné, 2000).

Where conceptual combination theories differ is in the relative importance they place each of the nouns that make up the compound. The CARIN model (Gagné, 2000; Gagné & Shoben, 1997) argues for the primacy of the modifier, showing that the frequency with which a particular relation (e.g., located, made-of) is associated with a modifier noun can predict the speed with which people use that relation in an interpretation (e.g., if the relation [located] is frequently associated with the noun *daisy* then *daisy cup* will be easily interpreted as "a cup containing daisies"). In contrast, concept specialisation theory (Murphy, 1990) leans in favour of primacy of the head, contending that the modifying noun acts to specialise the representation of the head noun. On the other hand, constraint theory argues for equal primacy of head and modifier (Costello & Keane, 2000), with both concepts given equal weight in the search for the best interpretation of a given compound. Finally, the PUNC model (Lynott et al., 2004) differs from all the above by arguing that that neither constituent noun has *a priori* primacy in the interpretation process, and that relative importance is dependent on each individual concept and that concept's internal structure. Clearly, there is little agreement on the relative importance of the constituent concepts in a noun-noun compound; an issue that needs to be resolved if we are to understand how people perform this complex microcosm of language comprehension.

Prosody and Conceptual Combination

None of the cognitive theories of conceptual combination in the literature to date have specified a role for suprasegmental information (e.g., prosodic information) in the comprehension of novel noun-noun compounds. This is a curious omission in light of the fact that general linguistic theories of language have noted the meaning-altering effects of prosody for a long time (Bresnan, 1971; Ladd, 1996), including effects on lexicalised compound phrases (e.g., Isel, Gunter & Friederici, 2003). Furthermore, the frequency with which novel noun phrases occur in the English language only adds to mystery of this oversight.

Broadly speaking, prosody refers to changes in aspects of speech such as emphasis, pitch, intonation, rhythm and timing. It is commonly recognised that changes in prosody can affect meaning. For example, words such as *contract* and *object* change meaning depending on which syllable

emphasis is placed. In investigating the possible effects of prosody on novel noun-noun compounds, there are essentially three possible prosodic patterns that need to be considered; namely modifier emphasis (emphasis on the first word; e.g., *CHOCOLATE cake*), dual emphasis (equal emphasis on both words; e.g., *CHOCOLATE CAKE*) and head emphasis (emphasis on the second word; e.g., *chocolate CAKE*). The question is whether using these different patterns affects the interpretation process in quantifiably different ways.

Connell (2000) observed that the same compound was read with different emphasis patterns when different meaning descriptions were attached. When one term is emphasised above the other, it is with the goal of conveying specific information by highlighting specific dimensions of the concepts concerned that might not be immediately obvious with an alternative emphasis placement (Ladd, 1996; Sproat, 1994). Therefore, it might be reasonable to assume that prosodic effects can work in the opposite direction, with different emphasis patterns leading to different meaning activations (Cutler, Dahan & van Donselaar, 1997) and therefore different responses. The following experiments allow us to examine whether patterns of prosodic emphasis facilitate or inhibit the comprehension process of novel compounds by presenting stimuli both in written form and with different prosodic emphases in auditory form.

Experiment 1

The aim of the first experiment is to examine the default distribution and speed of different interpretation types (i.e., property-based or relation-based) for the text presentation of novel concept combinations. This study focuses on novel noun-noun compounds (that are not already lexicalised in the English language) for two reasons: first, because understanding novel compounds involves performing the full process of combining constituent concepts rather than retrieving an existing meaning for the compound (Wisniewski, 1996); and second, because lexicalised compounds are already likely to have a conventional emphasis pattern that could confound the prosodic effect under investigation in this study.

Regarding the distribution of interpretation types, previous research has generally shown relational interpretations are more common than property-based interpretations, although the proportion of interpretations classed as property-based varies considerably between item sets, from 0.6% (Gagné, 2000) to 72% (Wisniewski, 1996).

Regarding the speed of different interpretation types, there is again considerable variation between item sets, with some empirical studies finding that people arrive at relation-based interpretations more quickly than property-based interpretations (e.g., Gagné, 2000) and others finding the opposite (e.g., Tagalakis & Keane, 2003).

Method

Materials Concepts were selected from 100 noun concepts used previously in literature from Costello and Keane (2000), Gagné and Shoben (2001), and Wisniewski (1996). The concepts used were a mix of artefacts, natural kinds, abstract concepts, object and non-object concepts (see Medin, Lynch & Solomon, 2000). A set of two-word combinations was generated by randomly selecting a modifier and head noun from this set (excluding compounds where the same word was used for both head and modifier). In order to ensure the novelty of test compounds, the British National Corpus (BNC: http://www.natcorp.ox.ac.uk), a 100 million word corpus of written and spoken British English, was searched for their occurrence. A pool of 27 novel compounds that did not occur in the BNC was used as test items. In addition, a set of 14 lexicalised compounds (with a BNC frequency greater than 20 per million words) was used as fillers.

Procedure Participants were seated in front of a Toshiba Laptop and told that they would be presented with two-word phrases onscreen; some of these phrases would be familiar to them, while others would not. They were instructed to press the key labelled "yes" to indicate that they could think of a possible meaning, or to press the key labelled "no" to indicate that they could not think of a meaning for the phrase. Response times (RT) were measured. If the "yes" key was pressed, participants were then asked to type in the interpretation they had just thought of. After a brief pause, the word "Ready" appeared on the screen for 2000ms after which the next stimuli was displayed. There was a short break halfway through the experiment. Prior to the experiment proper, each participant proceeded through a series of six practice trials, containing a mix of lexicalised and novel compounds not featured in the main experiment, to allow them to become accustomed to the procedure.

Participants Eighteen native English speakers were paid a nominal fee for their participation. One participant was excluded due to technical difficulties during the experiment. In order to ensure that participants were actually performing the conceptual combination task and not just responding positively to lexicalised fillers, the data of any participant who produced less than 25% sensible responses to test items were removed: one participant was excluded on this criterion.

Coding & Design Participant interpretations were marked as sensible if they described the compound as more than just the head noun (i.e., *elephant complaint* must be described as more than just "a type of complaint"): over 67% of test items produced sensible responses, a reasonable return given the difficulty of understanding phrases of randomly-paired nouns. Each sensible interpretation was then classified by two independent coders (blind to experimental conditions) as one of the following interpretation types: *property-based* (where a property of one concept is transferred to the other e.g., a *robin snake* as a snake with a red breast); *relation-based* (where a thematic relation is used to link the two concepts e.g., *robin snake* as a snake that eats robins); *hybrid* or equivalence interpretations (where the interpretation is a hybrid of the two concepts e.g., a *robin snake* is part snake and part robin). All other interpretations were classified as *other*. Agreement between coders was calculated giving a Cohen's Kappa of 0.96.

Table 1: Percentage of responses per interpretation type for each presentation condition.

Interpretation Type	Experiment 1 (text)	Experiment 2: Emphasis		
		Modifier	Dual	Head
Property	37%	39%	31%	36%
Relation	59%	53%	67%	58%
Hybrid	1%	3%	0%	1%
Other	3%	5%	2%	5%
N	*286*	*125*	*129*	*121*

Disagreements were resolved by discussion. Property- and relation-based interpretations accounted for 96% of interpretations (see Table 1). Since hybrid/other responses accounted for such a small proportion of interpretations, they will not be subject to any further analyses.

The experiment therefore had a single factor design with interpretation type (property-based, relation-based) manipulated within participants. Analyses of variance by participants and by items were carried out on response times per interpretation type.

Results & Discussion

Results showed that people produced significantly more relation-based than property-based interpretations (see Table 1), $F_1(1,15)=9.703$, $MSE=0.034$, $p=0.007$; $F_2(1,26)=4.774$, $MSE=0.160$, $p=0.038$. These results do not support Gagné's (2000) assertions that property-based interpretations are infrequently produced and not easily interpreted. While the majority of interpretations were relation-based, a large proportion (37%) was property-based. Given the compounds were random combinations of nouns taken from across the literature (including Gagné & Shoben, 1997), and hence were not biased towards particular interpretation types, this finding suggests that people have little difficulty in producing property-based interpretations.

Additionally, there was no response time difference between property-based ($M=3.706$, $SD=2.094$) and relation-based interpretations ($M=3.321$, $SD=1.922$), with relational responses being marginally faster by participants only, $F_1(1,15)=3.307$, $MSE=0.197$, p=0.089; $F_2<1$. This result differs from both Gagné (2000, with faster relation-based responses) and Tagalakis and Keane (2003, with faster property-based responses). However, the present finding shows that, at least for this item set of randomly paired nouns, there is no real processing advantage for relation-based interpretations.

In summary, the text presentation of novel concept combinations has shown that the default distribution is for relation-based interpretations to be more frequently produced than property-based interpretations (59& and 37%, respectively) but that there is little difference in the processing speed of these two different interpretation types.

Experiment 2

This experiment aims to examine whether the use of different patterns of emphasis (Modifier, Dual or Head emphasis) affect people's ability to comprehend novel concept combinations, with particular reference to the distribution and speed of property- and relation-based interpretations. Prosodic stress acts to facilitate information activation (Cutler et al., 1997), with stressed words being easier to process (Cutler & Foss, 1977) and more highly activated than unstressed words (Bock & Mazzella, 1983). As previously noted, no existing theory of the conceptual combination of novel compounds incorporates potential prosodic effects; however, the relative importance each theory places on the head and modifier nouns leads to different predictions.

First, let us consider the how the distribution of interpretation types may differ across emphasis conditions from the default, text presentation in Experiment 1. The CARIN theory holds to primacy of the modifier, stating that relational information is particularly tied to the modifier concept (Gagné, Spalding & Ji, 2005). For example, the compound *octopus apartment* may be interpreted as "an apartment where an octopus lives" if the relation [located] is commonly associated with the concept of *octopus*. If the activation of the modifier concept is increased, the CARIN view suggests that access to relevant relations will be facilitated and more relation-based interpretations will therefore be produced in the modifier emphasis condition (*OCTOPUS apartment*) compared to text presentation. In contrast, concept specialisation theory adheres to primacy of the head, where the modifier noun acts to fill a relational slot somewhere in the schema representation of the head concept (Murphy, 1990). For example, *octopus apartment* may be interpreted as "an apartment where an octopus lives" if the relational slot [location] in the concept *apartment* is filled by the modifier *octopus* This view therefore suggests that increasing activation of the head concept should facilitate slot location, which may lead to more relation-based interpretations in the head emphasis condition (*octopus APARTMENT*) compared to text presentation. Other theories do not expect prosody to alter the default distribution of interpretations types. For example, *octopus apartment* may be interpreted as either "an apartment where an octopus lives" or "an apartment with eight rooms". Constraint theory would expect head or modifier emphasis to cause increased weight for the corresponding concept in the conceptual combination process, but this would have no effect on whether relation- or property-based interpretations were more likely to ensue (Costello, personal communication, 2005). Similarly, the PUNC model (Lynott et al., 2004), with its position that primacy of head and/or modifier depends on the individual concepts comprising a given compound, suggests that prosody will have no overall effect on the distribution of relation- and property-based interpretations.

Second, we come to the processing speed of different emphasis conditions and interpretation types (although it is important to note that response times from Experiment 1 cannot be directly compared to those in this experiment because of different stimulus presentation modalities). As outlined above, the CARIN theory suggests that increasing activation of the modifier concept will facilitate access to relevant relations; therefore, this view may expect modifier emphasis (*OCTOPUS apartment*) to yield faster responses

(compared to the other emphasis conditions), in particular for relation-based interpretations (compared to property-based interpretations). On the other hand, concept specialisation theory suggests that increasing activation of the head concept will facilitate relational slot location; therefore, this may lead to responses in the head emphasis condition (*octopus APARTMENT*) being faster than other emphasis types, with relation-based interpretations faster than property-based interpretations. A different perspective comes from constraint theory, which suggests that both head and modifier concepts should be activated because they are equally important; therefore, this view may expect dual emphasis (*OCTOPUS APARTMENT*) to facilitate the fastest interpretations (whether relation- or property-based). Lastly, the PUNC model suggests that, since there is no *a priori* primacy of either head or modifier concept, prosody will have no overall effect on the response times; therefore, the default, text presentation pattern for relation- and property-based interpretations will be maintained.

Method

Materials Compounds were the same as in Experiment 1. To ensure consistency in pitch and emphasis levels, and to eliminate the possibility of unplanned cues, we used a high quality speech synthesis system (rVoice, 2005) to manipulate prosodic stress rather than rely on human readers. Audio files for each compound (with three different emphasis patterns - modifier, dual, and head emphasis), were created using rVoice's female, UK-English voice (F015) for all stimuli. A speech markup language, SSML (Speech Synthesis Markup Language), allowed precise manipulation of pitch and rate of utterance to construct a separate template for each emphasis pattern, where emphasis was achieved by increasing the pitch to 125% and reducing the speed of utterance to 85% for that portion of the phrase (see Sproat, 1994). The same templates were used for test and filler items, with each test item having three versions, and each filler item randomly assigned one emphasis type. All files were generated at high-quality, 32 kHz sampling frequency at 16-bit resolution, with the volume normalised for all files. Finally, in order to ensure the intelligibility and clarity of materials, three independent raters (blind to condition) were asked to transcribe test and filler items, and rate the overall quality of the sound file on a three-point scale from bad to good. All materials were correctly transcribed and unanimously judged to be of good quality.

Procedure Participants were randomly assigned to a test group so that each person only heard one version of each test compound, with equal numbers of emphasis types per group. The procedure was then the same as Experiment 1, except that participants were presented with two-word phrases through headphones rather than onscreen. Auditory stimuli were presented through standard closed-ear headphones (Unitone HD-1010) using a 16-bit sound card with 16 kHz digital sampling. Response times were measured from the onset of each stimulus. During the practise trials, participants had the opportunity to adjust headphone volume to a comfortable level.

Participants Thirty native English speakers were paid a nominal fee for their participation. Data of one participant were excluded because of technical difficulties during the experiment, as was one participant whose mean response time for sensible items was more than two standard deviations slower than the rest of the sample. As in Experiment 1, the data of any participant who produced less than 25% sensible responses to test items were removed: six participants were excluded on this criterion.

Coding & Design Sensible participant interpretations were classified by three independent coders (blind to condition) as per Experiment 1. Analyses of variance by participants and items showed there was no difference between emphasis types in the proportion of sensible responses produced: modifier emphasis = 64%, dual emphasis = 65%, head emphasis = 61%, [F_1<1; F_2<1; all pairwise comparisons with Bonferroni corrections non-significant p>0.99]. Agreement between coders had a mean Kappa of 0.83 with disagreements resolved by discussion. As in Experiment 1, the vast majority of interpretations were property- and relation-based (95%) and the small proportion of hybrid and other interpretations means they will not be subject to further analyses.

The experiment therefore had a three factor design with emphasis (modifier, dual, head) and interpretation type (property-based, relational) manipulated within participants and group between participants. Comparison with Experiment 1 was conducted across both sets of data with experiment treated as a between-participants factor. Analyses of variance by participants and by items were carried out on the proportion of responses and RT (sec) per interpretation type.

Results & Discussion

Results showed that emphasis type affected both the distribution and comprehension speed of novel concept combinations (see Table 1 and Figure 1).

There was a main effect of interpretation type, with more relation-based (60%) than property-based (36%) interpretations produced overall, F_1(1,19)=6.838, MSE=0.262, p=0.017; F_2(1,26)=5.818, MSE=0.420, p=0.023. There was no main effect of emphasis [F_1(2,38)=2.072, MSE=0.004, p=0.140; F_2(2,52)=1.058, MSE=0.009, p=0.355] and the interaction of interpretation type and emphasis was not significant [F_1(2,38)=1.535, MSE=0.085, p=0.229; F_2(2,52)=2.915, MSE=0.074, p=0.063]. The group variable showed no effects (all ps>0.3).

In planned comparisons of interpretation types per emphasis condition, people produced more relation-based than property-based interpretation for dual emphasis [F_1(1,19)=10.598, MSE=0.119, p=0.004; F_2(1,26)=12.845, MSE=0.161, p=0.001] but the proportions were not significantly different for either modifier emphasis [F_1(1,19)=1.199, MSE=0.135, p=0.287; F_2(1,26)=2.200, MSE=0.173, p=0.150] or head emphasis [F_1(1,19)=3.527,
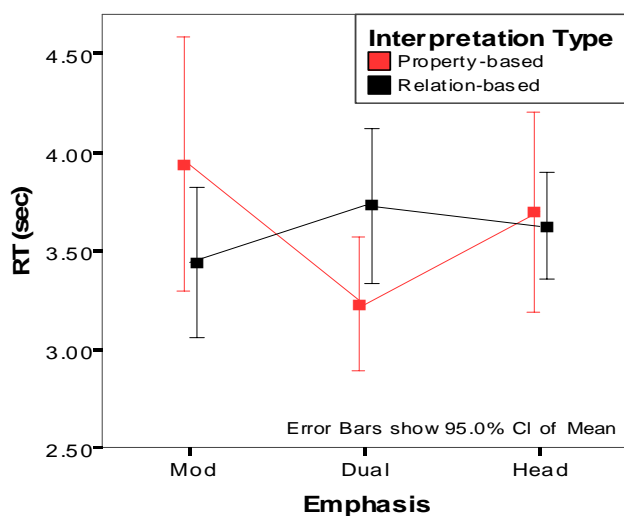
Figure 1: Mean comprehension times for property- and relation-based interpretations per emphasis condition

MSE=0.178, p=0.076; F_2(1,26)=1.816, MSE=0.235, p=0.189] conditions. Compared to the text presentation of compounds in Experiment 1, neither modifier [F_1<1; F_2(1,26)=1.772, MSE=0.023, p=0.195] nor head emphasis [F_1<1; F_2<1] significantly affected the proportion of relation-based interpretations produced. Dual emphasis resulted in more relation-based interpretations (67% compared to 59% in Experiment 1), although this difference was significant only by items, F_1(1,36)=1.589, MSE=0.050, p=0.216; F_2(1,26)=4.417, MSE=0.020, p=0.045.

There were no reliable main effects of either interpretation type [F_1(1,19)=2.676, MSE=1.259, p=0.118; F_2(1,26)=2.751, MSE=1.931, p=0.109] or emphasis [F_1(2,38)=1.303, MSE=1.795, p=0.284; F_2(2,52)=3.356, MSE=1.622, p=0.043]. There was, however, an interaction of interpretation type and emphasis [F_1(2,38)=7.341, MSE=0.677, p=0.002; F_2(2,52)=5.779, MSE=1.738, p=0.005]. The group variable showed no effects (all ps>0.1).

Planned comparisons showed that property-based interpretations were faster than relation-based interpretations in the dual emphasis condition, [property M=3.230, SD=1.066; relation M=3.728, SD=1.843; F_1(1,19)=5.643, MSE=0.365, p=0.028; F_2(1,26)=11.749, MSE=1.893, p=0.002], but response time differences were reliable only by participants for both modifier emphasis [property M=3.941, SD=2.445; relation M=3.441, SD=1.556; F_1(1,19)=4.499, MSE=1.815, p=0.047; F_2(1,26)=1.497, MSE=1.638, p=0.232] and head emphasis [property M=3.699, SD=1.676; relation M=3.628, SD=1.145; F_1(1,19)=7.123, MSE=0.433, p=0.015; F_2<1].

The notion of primacy of the modifier or head, as advocated by the CARIN theory (Gagné & Shoben 1997) and concept specialisation theory (Murphy, 1990) respectively, is not borne out by this study. If one constituent noun was indeed the most important component in the conceptual combination process (i.e., the source of linking relations, or relational schema slots), then increasing its activation through prosodic stress noun should have

facilitated both the frequency and speed with which people arrived at relation-based interpretations. However, modifier emphasis produced a similar (indeed, slightly lower) proportion of relation-based interpretations (53%) to text presentation (59%), as did head emphasis (58%). Any facilitation in response times was not reliable by items for either head or modifier emphasis.

With its idea of equal importance of head and modifier, constraint theory also fails to fit the results of this study. If head and modifier are both equally important, then equal activation through dual emphasis should facilitate the speed with which people can interpret the compound, although the frequency of property- and relation-based interpretations should not necessarily change. However, there was no overall difference in response times between emphasis types, and dual emphasis actually caused the proportion of relation-based interpretations to rise (67% compared to 58% for text presentation). The PUNC model (Lynott et al., 2004) has mixed success in accounting for the present findings. If the primacy of head and/or modifier depends on the compound in question, then any advantages afforded by prosodic emphasis will balance out across the item set. Indeed, this was the case, with no overall difference in response times between emphasis types. However, PUNC cannot explain why dual emphasis resulted in more relation-based interpretations, and faster property-based interpretations.

General Discussion

In this paper, we have considered the role of prosody in conceptual combination, presenting the first empirical study to explicitly consider the effects of prosodic stress patterns on the processing and interpretation of novel noun-noun compounds. Experiment 1 showed that randomly-generated compounds, when presented in text form, produced more relation- then property-based interpretations but with no accompanying difference in comprehension time. Experiment 2 showed the novel effect of prosodic emphasis on conceptual combination, with modifier emphasis (e.g., *OCTOPUS apartment*), dual emphasis (e.g., *OCTOPUS APARTMENT*), and head emphasis (e.g., *octopus APARTMENT*) showing different results. Dual emphasis caused people to produce more relation-based interpretations (67%) than they did for text presentation (59%), but no difference was found for modifier and head emphasis. Dual emphasis also meant people were faster to arrive at property-based interpretations than relation-based interpretations, but modifier and head emphasis conditions followed the pattern of text presentation with no reliable difference in response times.

So, how does text presentation of noun-noun compounds relate to spoken presentation? Given that modifier emphasis is by far the most frequent stress pattern for noun-noun compounds in English (Connell, 2000; Sproat, 1994), and that people impose prosodic contours on words during silent reading (Fodor, 2002), it could be argued that people will impose modifier emphasis on any novel noun-noun compound encountered in reading. This notion fits with the similar profile of results found for text presentation and modifier emphasis, but fails to explain why head emphasis

produces the same profile, or why dual emphasis differs in the way it does.

Why does modifier and head emphasis fit the pattern of text presentation relatively closely, only for dual emphasis to differ? It appears that emphasising both concepts equally produces a counterintuitive result: people are faster to produce property-based interpretations but more likely to produce relation-based ones. This finding may be explained by considering how relational and property information is used in the interpretation process. For example, when interpreting a compound, a person may first arrive at either a relation-based or a property-based interpretation (e.g., an *octopus apartment* could be "an *apartment* where an *octopus* lives" or "an *apartment* with eight rooms"). If equal activation of both concepts makes a potential linking relation more obvious (e.g., that an *octopus* must live somewhere and something must live in an *apartment*), then dual emphasis could lead to increased proportions of relation-based interpretations (even if it still takes some time to mesh this information into an interpretation). At the same time, if equal activation of both concepts allows parallel properties to be identified more rapidly (e.g., an *octopus* has eight arms and an *apartment* has a certain number of rooms), then dual emphasis could lead to faster processing of property-based responses (even if most people still opt for the more obvious relation-based interpretation). Thus, dual emphasis appears to make relational information more obvious (so more people first arrive at relation-based interpretations) while at the same time making property-based interpretations faster to process (so people creating property-based interpretations have faster responses). Such a possibility is worthy of further investigation.

Overall, the present findings suggest that conceptual combination during comprehension of text and speech may utilise some different processes. Reading noun-noun compounds may allow people to employ some strategies (e.g., shifting focus between head and modifier) that are enabled by having both words present on the page or screen. In contrast, hearing noun-noun compounds in speech may make such strategies difficult because the phonological loop does not offer the same flexibility in manipulation as a written stimulus. The possibility of focus-shifting during conceptual combination in reading is the subject of ongoing research.

Acknowledgments

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