Lexical Ambiguity Resolution of Related Meaning Words:

The Effects of Isolating and Activating Unique Features

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Abstract

Many studies have been conducted to determine how lexical ambiguity is resolved. The present study examines ambiguous words with related meanings. Related meanings were used to show the extent to which contextually activated features facilitate the activation of the meanings of ambiguous words. It was predicted that only one of the related meanings of the ambiguous word would be activated when features were activated by a context that was related to just that meaning. The unique features of the dominant and subordinate meanings of ambiguous words were isolated, and the context was biased towards these features. The finding demonstrate that selective activation of meanings occurs for ambiguous words with related meanings and support a feature sensitive model of ambiguity resolution.

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Many words in the English language can be considered ambiguous. People rarely have stop to consider ambiguity in everyday reading and speaking because language must be processed in such a way that ambiguity is resolved almost automatically. How does ambiguity get resolved so quickly?

Several models have been developed to describe how the ambiguity resolution could occur in a language processor. The models are constantly being adapted as more information is learned about how language is processed. Most of the literature has focused on how context influences the resolution of ambiguity, but recently it has been found that relatedness of the meanings features is also important. It has been found that the unshared features of related meaning ambiguous words are context dependent and the shared features are context independent.

Originally a modular model was developed that was entirely context independent. It assumed that a lexicon or mental dictionary worked independently without the aid of semantics or syntax to determine the meaning of a word. When it was found that frequency and context both had roles in ambiguity resolution, an interactive-activation model was introduced to account for their influence. In the model, semantics and syntax had an influence on the lexicon in a top down manner, and the lexicon influenced semantics and syntax.

The interactive-activation model was supported and modified by the findings of Vu, Kellas, and Paul (1998). It was determined that the ambiguity of a word could be resolved based on the strength of the context that it is found in because the context activated the only features of the meaning that it is biased towards. The ambiguous words were place in three different contexts. The first two contexts were strongly biased towards the dominant or subordinate meaning of an ambiguous word. The third context was unrelated to either meaning of the ambiguous word. When the ambiguous word was placed in a sentence that was strongly biased towards its dominant meaning, only its dominant meaning was activated. In subordinately biasing context, only the subordinate meaning was activated. When the context was ambiguous, both the dominant and subordinate meaning of the word were activated. The findings led to the conclusion that a context-sensitive model of ambiguity that accounted for the influence context strength should be adopted. Later it was found that the the model that was developed did not fully take into account the influence of features on ambiguity resolution. Vu et al. looked at meanings that had totally unrelated features. If ambiguous words with shared features that overlap each other in the semantic network had been used, the result might have been quite different.

Azuma and Van Orden (1997) looked at the effects that shared features have on lexical decision times. It was found that words in isolation with related meanings or shared features are responded to more quickly in a lexical decision task than those with unrelated meanings. It was assumed that faster response times were due to the greater overlap of shared features. The similar activation patterns that resulted from the shared features reduced the amount of

competition from unshared features. The reduction was due to the higher activation of words with related meanings and caused the increase in lexical decision time. Since the experiment was conducted using words in isolation, it can be assumed that the shared features of the word with related meanings are context independent. The effects of meaning relatedness effects should be further examined by placing ambiguous words with shared features in the context of a sentence so that the effects of both can be examined to see what role each plays in the resolution of ambiguity.

Metcalf, Kellas, and Vu (1999) demonstrated that the effects of meaning relatedness can outweigh those of context. Metcalf et al. found that both meanings of an ambiguous word with related meanings were activated even when the word was placed in a strongly biasing context. The shared features of related dominant and subordinate meanings had an important influence on meaning activation. The influence was even greater than that of the constraints placed upon the activation by a strongly biasing context. Metcalf et al. found multiple activation of the meanings due to featural overlap. If the context was biased towards only the unique features, multiple activation would probably not occur because only the unshared features of the related meanings would be activated.

The present research examined whether it was possible to selectively activate only one meaning of an ambiguous word with related meanings. To do this, the unique features of the meanings were isolated. The words were then placed in a context which was strongly biased towards the unique features of either the dominant or subordinate meaning of the word. It was hypothesized that only the meaning that the context was biased towards would be activated. It would show that there is selective access for the meanings of related words when the context was biased towards the unique features of its meaning.

Method

Participants

The participants were 48 students at a large Midwestern university. All of the participants were native English speakers and had normal to-corrected-to normal vision. Six of the participants participated in eight different lists of stimuli.

Stimuli

Norming the Relatedness of Ambiguous Words. To norm the relatedness of ambiguous words, words with two distinct noun meanings were selected from the homograph association norms of Azuma (1996), Nelson, McEvoy, Walling, and Wheeler (1980), and Twilley, Dixon, Taylor, and Clark (1994). The dominant and subordinate meanings of these words were also taken from these norms. Short definitions corresponding to each of these meanings were taken from the dictionary.

The ambiguous words and their dominant and subordinate definitions were randomly assigned to three packets which each contained 40 words. These packets were then given to 120 participants who rated the degree of relatedness between the two meanings. The words were presented with 20 in one order and 20 in the reverse order. The participants judged the degree of relatedness between the two meanings which were given for each word using a nine point scale. The following example demonstrates the definitions of a word and the scale:

COAT

1. A sleeved outer garment worn for warmth.

2. The natural covering of an animal; fur.

1 2 3 4 5 6 7 8 9
not related very related

The scale ranged from one or not related to nine or very related. The 60 words with the most related meanings were selected from these procedures which were based on Metcalf et al. (1999). These related words had a mean of 5.09.

Feature Norming. To norm the features of the 60 ambiguous words which were selected from the relatedness norms described above, 240 participants were asked to generate the features of each meaning of the ambiguous words. They were given a packet of 20 ambiguous words each on their own page followed by 10 blank lines. Participants were told to list the features of the word in order as they came to mind. It was suggested that they write down items related to the word's physical, perceptual, and functional properties. Ten participants completed each packet, and another 10 received the exact same packet with the words in reversed order.

The participants generated a total of 19,196 features for all of the ambiguous words. The generated features were tallied, and each feature was represented by a word. A distribution was made based upon the number of times a feature was given by the participants. To choose the unshared features, the feature lists were compared. The highest occurring features for both the dominate and subordinate meaning were chosen as their target words. To insure that the feature could be considered unshared, a stipulation was made that the chosen target could not appear on both the dominant and subordinate feature lists. Next the targets were used in a norming and naming task.

Context Strength Norming. Two sentence frames were created for each ambiguous word. The restriction for these frames was that the sentences were made up of a subject noun, verb, and direct object. The direct object was both the last word of the sentence and the ambiguous word. One of the sentences was strongly biased towards the dominant meaning of the ambiguous word. The other sentence was written to be strongly biased toward the subordinate meaning of the ambiguous word. Six lists were then made by randomly assigning the sentences and 20 participants were asked to judge the degree of bias for 40 sentences. Participants rated each of the sentences for the degree that the context was biased in the direction of one of the meanings of the ambiguous word. A nine point scale was provide on which the associate for the dominant meaning of the ambiguous word was placed under one on the scale and the subordinate meaning was place under nine. The associates were chosen from the above feature norms. A sample sentence follows:

The coach approached the **batter**.

1 2 3 4 5 6 7 8 9

BASEBALL CAKE

Forty ambiguous words and their sentences were chosen based on the feature generation and strength norming tasks mentioned previously. Strongly biasing contexts had a mean rating of 1.39 for bias toward the dominant meaning of the ambiguous word. A mean rating of 8.5 was found for contexts that were biased towards the subordinate meaning of the ambiguous word.

In the naming task, the same dominant and subordinate targets were used. Eight lists were formed with the 40 target words so that the participant saw all of the ambiguous words only once. The sentence prime, dominant or subordinate, was paired with two related targets and two unrelated targets. The unrelated were selected by re-pairing related primes and targets at random so that no prime or target was repeated for any participant. To keep the participants from noticing the ambiguity, a set of 40 unambiguous filler items were mixed in with the ambiguous items. Thirty-six sentences served as practice items. Twenty-four of these items had an ambiguous word, half of which were biased towards the dominant meaning and the other half towards the subordinate meaning. The remaining 12 were unambiguous. Sample stimuli for the word court are shown in Table 1.

Insert Table 1 about here

Design

A twoxtwoxtwo within-subjects factorial design was used. The factors were sentence prime (dominantly biasing or subordinately biasing), target dominance (dominant target or subordinate target), and target relatedness (target related to context or target unrelated to context).

Apparatus

A 486 IBM personal computer with an ACER Multi-sync color monitor was used to

display the stimuli. The presentation rate of the stimuli was synchronized with the refresh rate of the monitor. Participants spoke into a Shure Brothers Incorporated microphone which was attached to a Grason-Stadler #E7300A-1 voice operated relay (VOR). The VOR was connected to the computer to signal verbal responses. Response times were measured to the closest millisecond from the onset of the target to the triggering of the VOR by a vocal response.

Procedure

Participants were asked to read and sign a consent form which explained the experiment. The instructions which the participants were given told them to read each sentence carefully for comprehension because they would frequently be asked a question about the sentence. They were also instructed to read the word in capital letters which followed the presentation of the sentence out loud as quickly and as accurately as possible. All of the participants were tested in a dimly lit room where they were seated about 60 cm from the computer monitor so that the targets subtended an average visual angle of 1.6 degrees horizontally and 0.5 degrees vertically.

At the beginning of a trial, a series of word length lines separated by single spaces appeared on the screen. The lines were cues which signaled the location and length of the words in the sentence. Sentences were presented starting on the left side and at the vertical center of the computer screen. Sentence primes were displayed entirely in lower case letters except for the first letter in the sentence which logically was capitalized. The target words were presented in all capital letters to distinguish it from the sentence. A modified unfolding procedure was used as the display format in which each word was presented one at a time at a rate of 237 milliseconds per word. The words remained on the screen until the final word in the sentence was completely displayed (cf Just, Carpenter, & Woolley, 1982). The final word in the sentence was displayed for only 80 milliseconds to avoid allowing the participant time to access both meanings of the ambiguous word. Immediately following the offset of the final word in the sentence, the sentence was removed and a target word was placed six character spaces to the right of where the end of the sentence had been. The participant then read this word out loud. A WH-comprehension question was asked randomly during 20 percent of the trials to ensure that the participants were

reading the sentences for comprehension.

The accuracy and legality of the responses to these questions were monitored by the experimenter. Errors were recorded on trials where the participant gave incomplete responses or mispronounced the word. Sounds which triggered the VOR too soon or responses which initially failed to trigger it were also considered errors. Each trial was separated by a 2500 millisecond time interval. Participants were exposed to total of 116 trials. The first 36 trials were considered practice and were not examined or included in the analysis of this experiment. When participants completed the trials, they were given a debriefing statement which explained the experiment.

Results

Data from 12 participants was removed due to comprehension errors that resulted in less than 75% accuracy. Comprehension accuracy for the remaining participants was 86.4%, and naming errors constituted 5.1% of the data.

Mean correct naming latencies were submitted to a prime type (dominant, subordinate) X target dominance (dominant, subordinate) X target relatedness (related, unrelated) analysis of variance for repeated measures, using participants as the random variable. All reported effects are significant at $p < .05$.

The findings indicated that meaning relatedness can facilitate naming latencies in the appropriate context. When the context and the target were biased towards the unique features of the dominant meaning, the dominant meaning was more activated than the subordinate. When the context and the target were biased towards the unique features of the subordinate meaning, the subordinate meaning was more activated than the dominant. Selective access was found for ambiguous words with related meanings. A combination of the results is displayed graphically in Figure 1 and are supported by the following statistical outcomes.

Figure 1 about here

There was a reliable effect of target dominance F (1,47)=10.58, MSe=1730.83 in which dominant targets were named faster than subordinate targets. There was also a reliable effect of target relatedness F (1,47)=19.61, MSe=1141.57 in which related targets were named faster than unrelated targets. There was a significant interaction of prime type X target dominance F (1,47)= 21.08, MSe=930.36. Both main effects and the interaction are qualified by the interaction of prime type X target dominance X target relatedness F (1,47)=7.53, MSe=1225.83. No other main effects or interactions were significant.

General Discussion

The results of the experiment show that there is selective access for one of the meanings of an ambiguous word with related meanings when the context is biased towards the unique features of that meaning. The experiment shows that there is facilitation for the meaning that the context is biased towards. In a dominantly biasing context, the dominate target is facilitated relative to the subordinate target. In a subordinately biasing context, the subordinate target is facilitated relative to the dominant target. The results support and extend the findings of Metcalf et al. (1999) because it was shown that the unique features of related meanings can be isolated. When the unshared features are activated by the context, only the meaning that the context is biased towards is facilitated.

Taken as a whole, the present research combined with the work of Azuma and Van Orden (1997) and Metcalf et al (1999) suggest that the context-sensitive model proposed by Vu et al. (1998) should be extended to account for the influence of the relatedness of features on lexical ambiguity resolution. The context-sensitive model assumed that all features of the meanings of ambiguous words are context dependent. Further research has led to different conclusions. Only the unshared features of related meaning words are context dependent. The shared features are context independent. A feature sensitive model should be considered to account for the fact that the shared and unshared features of related meanings can be isolated and that each type of feature

responds differently to contexts that are biased towards it.

Future research should further examine the influence of features on ambiguity resolution. One possible experiment that could be done to test the feature sensitive model would be to place the same ambiguous words that were used in the experiment in an ambiguous context. The outcome of such an experiment should show multiple access for both meanings of the ambiguous word if the feature sensitive model is correct. To further extend the scope of the research, the features of the ambiguous words could be classified into various properties to examine if properties of features also have an impact on ambiguity resolution. As more is learned about lexical ambiguity, the feature sensitive model will probably need to be modified or replaced to account for new findings.

References

Azuma, T. (1996). Familiarity and relatedness of meanings: Ratings for 110 homographs. Behavior Research Methods. Instruments & Computers, 28, 109-124.

Azuma, T. & Van Orden, G.C. (1997). Why safe is better than fast: the relatedness of a word's meaning affects lexical decision times. Journal of Memory and Language, 36, 484-504.

Just, M., Carpenter, P., & Woolley, J. (1982). Paradigms and processes in reading comprehension. Journal of Experimental Psychology: General, 111, 228-238.

Metcalf, K., Kellas, G., & Vu, H. (1999). Limits of contextual constraint on lexical ambiguity resolution? 40th Annual Meeting of the Psychonomic Society. Los Angeles.

Nelson, D., McEvoy,C., Walling, J. & Wheeler, J., Jr. (1980). The University of South Florida homograph norms. Behavior Research Methods and Instrumentation, 12, 16-37.

Twilley, L., Dixon, P., Taylor, D. & Clark, K. (1994). University of Alberta norms of relative meaning frequency for 566 homonyms. Memory and Cognition, 22, 111-126.

Vu, H., Kellas, G., & Paul, S.T. (1998). Sources of sentence constraint on lexical ambiguity resolution. Memory and Cognition, 26, 979-1001.

Table 1

Sample Stimuli

Sentence Primes	Targets	
	Related	Unrelated
Dominant The jury entered the court.	Judge	Movie
Subordinate The players entered the court.	Tennis	Window

Figure Caption

Figure 1. Selective access was found for ambiguous words with related meanings, using participants as the random variable.