Separating Associations from Semantics: Differences in Priming and Judgments

Erin Buchanan

University of Mississippi

William S. Maki

University of Arizona

Erin Buchanan

University of Mississippi

Department of Psychology

PO Box 1848

Phone: 662-918-1075

Email: embuchan@olemiss.edu

Abstract

Several experiments are performed here to show the differences in associative and semantic memory through priming and judgment tasks. A hybrid judgment and RSVP task was created from the work of Maki (2007a; Maki, Frigen, & Paulsen, 1997) and Davenport and Potter (2005). This hybrid task was used to show the early and persistent processing of associative information over semantic information. In three experiments, associative information was primed separate of semantic information, predicted both associative and semantic judgments and those judgments were faster than semantic relatedness judgments. These results are used to discuss the nature of associative memory processing and support an information hierarchy in memory storage.

Separating Associations from Semantics: Differences in Priming and Judgments

Semantic memory is the memory store that contains all the dictionary knowledge or facts we have gathered into the meaning of words (Tulving, 1993). The interconnections between the meanings of words were discovered and are studied through the use of semantic priming. Semantic priming occurs when there is a facilitation of processing (i.e. faster reaction times for reading) of one word following the presentation of a word related in meaning (Meyer & Schvaneveldt, 1971). So, if people are reading about MONEY or LOANS, the word BANK is much easier to process because its related meanings have already been activated in semantic memory.

A model used to understand semantic priming, in much the same way as Collins and Loftus (1975) originally outlined, is the Interactive Activation Model (Stolz & Besner, 1996). The Interactive Activation Model (IA) was first proposed to understand how word context would change letter perception (McClelland & Rumelhart, 1981). A visual input layer is first activated, which contains physical feature letter nodes. These features nodes are then connected to a layer of letter units, which in turn are connected to the words they spell. Stolz and Besner (1996; 1999) have expanded this model to explain semantic priming and furthermore, the absence of semantic priming. After the word level that is present in the original IA model, they added a semantic store where words are connected to their meanings.

The main difference between Collins and Loftus-like (1975) spreading activation models and the IA model is that words are not connected to each other in the IA model, only to their meanings. Within each level of the IA model (i.e. word level or semantic store) there are negative links, which prohibit words or semantic information from activating each other. The only positive connections are between levels, which go both upwards to the next higher level (i.e. words to semantic store) and back down to lower levels of analysis, which provides support for the currently activated word (Stolz and Besner, 1996). Semantic priming occurs in the positive connections between the word and semantic levels. The information in the semantic level is already activated when the second word is being processed in the word level; therefore any overlap they have in meaning is already activated.

The IA model has also been used recently to explain how blocking of semantic information can occur (Smith & Besner, 2001). The connection that flows downward from the semantic level to the word level is blocked so that information about features or meaning is not sent back to the word level, which prohibits semantic priming (Stolz & Besner, 1996). Hutchison and Bosco (2007) have recently called this idea “pathway blocking” because the path from semantics to lexical information is ignored. They have also outlined “activation suppression” which is when activation of a concept or its features is suppressed due to task demands. Both mechanisms could explain why different levels of priming and a lack of priming are found in the literature.

One issue with semantic priming has been the use of self-selected stimuli for experimental research. Semantic relationships are not the only type of relationship between pairs of words. Associative relationships are said to be the relationships of words that occur together frequently in text and speech, such as HELP and WANTED (Nelson et al., 2004). Fischler (1977) was one of the first experimenters to try to separate associative connections to get “pure” semantic priming using a lexical decision task. Many others have followed suit showing only semantic priming (McRae & Boisvert, 1998), only associative priming (Thompson-Schill, Kurtz, & Gabrieli, 1998) or a combination of both types of priming (Hodgson, 1991; Williams, 1996; Ferrand & New, 2004) using traditional priming techniques such as naming and lexical decision. These studies selected word pairs that appeared to have one relation or the other, and then experimenters normed the words by having participants rate the word pairs. Word pairs were then generally passed down experiment-to-experiment, which just perpetuates the use of words that are not controlled. The problem was and is that most studies of pure semantic priming have weak to moderate associative relationships (Lucas, 2000).

With the advent of large databases of associative (Nelson, McEvy, & Schreiber, 2004) and semantic (Maki, McKinley, & Thompson, 2004; McRae, Cree, Seidenburg & McNorgan, 2005) norms, controlling for opposing relationships has become much easier. The Nelson et al. (2004) free association norms contain over 72,000 word pairs created participants complete a free association task, which required them to name the first word thought of given a cue word. Forward strength (FSG) is the probability that the first word listed will elicit the response word, while backward strength (BSG) is the probability that the response word will elicit the cue word. Cueing with the word CAT will bring to mind the response MOUSE about 26% of the time (FSG for CAT-MOUSE), while MOUSE will elicit CAT about 54% of the time (BSG for CAT-MOUSE). These strengths can be reversed for the pair MOUSE-CAT. Free association measures lexical information that is due to experience, so common phrases and culture are embedded in the norms (such as the word pair ROCK-ROLL).

Similar to a free association task, feature production tasks are tasks that required that participants make a list of necessary features for an object (such as legs, tail, fur, etc. for the word DOG). McRae et al. (2005) normed 541 living (DOG) and nonliving (KNIFE) concrete words by asking participants to list features of word including the word’s physical properties (how it looks) and functional properties (what it is used for). Vinson and Vigliocco (2007) also had participants create feature lists for word with very similar results (Maki & Buchanan, 2008). To compute the relatedness between words, the cosine (COS) of the related features was created.

WordNet is a large-scale electronic dictionary that links words through a hierarchical network, where nodes are linked by relationship (such as is-a or has-a). This dictionary has been used to create another measure of semantic similarity, the JCN, which is named after Jiang and Conrath (1997) who created the measure (Maki et al., 2004). JCN measures semantic distance by combining information on how far along the hierarchy a word appears (i.e. how specific it is) and how far (how many links) it is from the word it is paired with. All of these databases provide an easy and efficient way of dissociating associative and semantic priming by directly creating word pairs without the opposing relationship.

The experiments presented here are designed to dissociate semantic and associative priming by making use of these databases. Word pairs were created with orthogonal relationships, so that priming was exclusively due to one relationship or another. Studying the separation of associative and semantic priming will help illuminate how associations fit into current models of priming, especially the IA model which already explains priming. Associative links have been speculated to be stored between words at the lexical level (Williams, 1996), which would indicate that priming for associations would be present without semantics. Furthermore, associative links stored at the lexical level would imply that associative information cannot be restricted or blocked as with previous findings of semantic blocking (Smith & Besner, 2001).

Further support for semantic blocking can be seen with word pair judgment tasks. Participants in this judgment task are required to view pairs of words and judge them on their associative relationship by asking how many people out of a 100 would name a response word given a cue word (i.e. 76 people would say FOUND in response to LOST). These ratings are then compared to their forward strength value (FSG), which should correspond one to one if ratings were perfectly aligned with their strength values. However, Maki (2007a) found that participants consistently overrate word pairs, so that the relationship between judgment and actual relationship is linear with a slope of less than .5. Participants decreased ratings when word pair relationships are set to zero, but the ratings are still 10 to 12 percent higher than the actual relationship. Even after discrimination training, participants continue to be insensitive to associative strength (Maki, 2007b).

This insensitivity also seems to pertain to feature overlap judgments on semantic word pairs, however (Maki, Krimsky, & Munoz, 2006). Participants were again asked to judge pairs of words, but this time on their feature overlap (i.e. how many features these items share). Participants were able to perform this judgment and had very high ratings of inter-rater reliability. However, some interesting findings happened when both semantic and associative judgments were put together in the same experiment (Buchanan, Maki, & Patton, 2007). Word pairs were created with both semantic and associative links and the word pairs were judged on either type of relationship. Participants were given descriptions of semantic and associative relationships and asked to rate word pairs on their relatedness. Participant ratings were compared to relatedness values from the databases mentioned. It appeared that semantic information was blocked during the associative judgment task because semantic relatedness values did not predict participant’s judgments in the associative judgment task. However, associative information seemed to be available because it predicted participant’s ratings in both associative and semantic judgment conditions.

Apparently, selectively attending to associative information during memory judgments blocks use of semantic information (but not vice versa). But we do not know whether the locus of this blocking of semantic information is early or late during the cognitive processes engaged by the judgment task. The blocking effect could arise early in processing if selective attention to associative information prevents activation of semantic features. The effect could occur later in processing if semantic information is activated and available but ignored when judging associative strength. The experimental task then is to determine whether semantic information survives associative processing. If it does, then we would conclude that the locus of the blocking effect is relatively late in the sequence of processes leading to an associative judgment.

The persistence of semantic information beyond stimulus presentation has been investigated mainly with the use of priming tasks. In the general case, two words are presented sequentially. If the first (prime) word is semantically related to the second (target) word, then both the speed and accuracy of identifying the second word are increased (see Hutchison, 2003, for a review). In this experiment, we created a variation on the priming task appropriate for assessing the persistence of semantic information beyond the act of making a memory judgment. We used the rapid serial visual presentation (RSVP) technique that has been shown to be sensitive to semantic and associative relations among words (e.g., Davenport and Potter, 2005; Maki et al., 1997). In our hybrid task, each trial began with a judgment made on a pair of words that were presented simultaneously; then followed a stream of rapidly presented distractors that contained one target word and the subject was asked to recall the target. In some of these trials, the target was associatively or semantically related to one of the judgment words. In other trials, the target word was not related to either of the judgment words.

Based on the previous RSVP research, we expected increased accuracy in recalling the target word when the priming word in the judgment pair was related to the target. If associative judgments only activate associative information (as it appears with the judgment tasks in Experiment 1) then semantic priming should be reduced from as compared to a semantic judgment condition or even completely prevented. However, both semantic and associative information appears to be activated during a semantic judgment task. Therefore, during the semantic judgment trials both semantic and associative priming should be seen.

Experiment 1

Method

*Participants*

All 36 participants were recruited from the human subjects’ pool, and all participants received general psychology course credit for their participation. Participants were excluded from the analysis if they performed below 20 percent correct on the RSVP task. Two participants were excluded from this analysis: these two participants performed below 20% correct, usually by typing one of the judgment words instead of the RSVP stream word.

*Design*

See Figure 1 for a visual demonstration of the hybrid task. Each trial in the experiment consisted of two parts. The trial began with a pair of words to be judged semantically or associatively. The second part consisted of an RSVP list of distractors that contained one target word; the target word was associatively related, semantically related, or completely unrelated to one of the words in the judgment pair (the priming word). The target word appeared at one of three serial positions in the RSVP list (1, 3, or 6). Thus the complete 2 x 3 x 3 within-subjects design included as factors Judgment Type, Prime-target Relation, and Lag.

*Materials*

A total of 216 triplets of words were selected using associative (Nelson et al., 2004) and semantic (Maki et al., 2004) databases. Each triplet contained two words used in the judgment phase of each trial. The third word was the target word that appeared in the RSVP stream. One of the judgment words, the prime, was strongly related associatively or semantically to the target word; the other judgment word was not related in any way to the target. The two words in the judgment pairs were modestly related, both associatively and semantically, to each other. For example, in Figure 1 HORSE-COW-PONY is the word triplet presented. HORSE-COW is the judgment pair that would be associatively or semantically judged. HORSE-PONY is an example of a semantically related prime-target pair because the words share features, such as TAILS, CAN RIDE, GALLOPS, etc. COW-PONY are unrelated in the semantic and associative database.

See Table 1 for means for the materials listed here. For associative word pairs, the forward association was kept as high as possible, while insuring no backward relationships and keeping the semantic similarity measure very low. The same procedure was used to create semantic word pairs; semantic similarity was kept high, while association was kept low. For example, DEVELOP and CREATE are semantically related but only weakly associatively related; PEANUT and BUTTER are strongly associatively related but weakly semantically related. The 54 associative prime-target pairs were strongly related in the forwards direction, and these associative pairs were only weakly related semantically. The 54 semantic prime-target pairs were strongly related semantically but weakly related associatively.

The words in each of the remaining 108 prime-target pairs were not related to each other. These unrelated pairs were created by randomly re-pairing words in the databases so that these pairs were neither associatively nor semantically related. The unrelated pairs were used as a baseline to evaluate priming and also to control for relatedness proportion, which is the ratio of related pairs to unrelated pairs. This ratio was kept at 0.25 for each of the different pair types or 0.5 for the whole experiment.  For example, SAYING and SCALE are neither associatively nor semantically related.

Judgment pairs were created by combining each prime word with another word that was both semantically and associatively related to the prime word.  Regardless of the prime-target relation, the words in the judgment pairs were always related, both associatively in the forwards direction and semantically (See Table 1). Both relationships were allowed because both semantic and associative judgments were made on the same pairs (by different participants). For example, in the triplet ROAR-LION-SCREAM, the judgment pair was ROAR and SCREAM and the prime target pair was ROAR-LION; LION and SCREAM were unrelated.

The 216 triplets were randomly divided into two sets. Each set contained 27 associative prime-target pairs, 27 semantic prime-target pairs, and 54 unrelated pairs. Each participant experienced both sets of word triplets. One set was assigned to the associative judgment condition and the other set was assigned to the semantic judgment condition. These assignments and their ordering within a session were counterbalanced across participants.

For the judgment pairs, a fixation cross was presented in the middle of the screen, and the judgment words were presented with one word (the prime) above the fixation cross and the other word below the fixation cross. These judgment pairs subtended visual angles of 2.00o horizontally and 2.54o vertically from a viewing distance of 45 cm, and individual words subtended visual angles of 2.00 o horizontally and 0.60 o vertically.

Distractors and target words in the RSVP streams were presented at the center of the monitor screen, each for 67 ms; presentations were synchronized with the 75 Hz refresh rate of the color monitors. Distractor stimuli consisted of a random combination of 8 characters drawn from the set of numbers {0-9} and a set of seven symbols {@ # $ % ^ & \*}. Like judgment words, distractors and targets also subtended visual angles of 2.00 o horizontally and 0.60 o vertically.

## Procedure

At the beginning of each trial, participants were shown the judgment pair but were instructed to withhold the judgment until after the RSVP task. The judgment pair was presented for 1000 ms before the start of the RSVP stream. The RSVP stream always contained 10 items: one target and 9 distractors. The target word was shown after 1, 3, or 6 distractors. After the RSVP stream ended, participants were presented with a prompt to type the target word.  After the RSVP word was entered, the judgment pair reappeared with instructions on how to judge the words. The judgments were described as either associative or semantic, as described in Maki et al. (2006) and Maki (2007a). The judgment was entered by typing the number (0-9) corresponding to the judgment and pressing the enter key (See Figure 1 for an example). The next trial then commenced.

Results and Discussion

Judgments

The asymmetrical judgment effects found in other studies were replicated in this experiment (Maki 2007, Maki et al., 2004); the semantic measure (JCN) only predicted semantic judgments but the associative measure (FSG) predicted both associative and semantic judgments. Two multiple linear regressions were performed using FSG and JCN as predictors of word pair ratings in the associative and semantic judgment conditions. Associative judgments were predicted significantly by FSG (β= +0.247, t = 3.706, p < 0.001), but not by JCN (β = +0.021, t = 0.309). When making semantic judgments, both FSG (β = +0.191, t = 2.901, p < 0.01) and JCN (β = -0.195, t = -2.956, p < 0.01) predicted ratings of these word pairs.

*Priming*

Accuracy of recalling the target from the RSVP stream was the dependent variable of interest. For both associatively- and semantically-related pairs, priming was defined as the difference between the proportions of correctly identified targets for related and unrelated pairs. The average difference scores are presented in Figure 2 separately for both types of priming (associative vs. semantic), RSVP lag (1, 3, vs. 6), and for both types of judgmental instructions (associative vs. semantic). Strong priming effects were found in all conditions, and associatively primed words were reported more frequently than semantically primed words. However, the amount of priming, both associative and semantic, was *not* influenced by the type of judgment.

Overall, participants were fairly accurate at the RSVP task, M=.72, SE=.17 (averaged across lag and judgment type). Guessing was also minimal, occurring in only 2% of trials over all participants. Guessing was measured by examining the number of trials in which a participant named a word semantically or associatively related to a judgment word. The differences in priming were assessed by a 2 X 2 X 3 (word pair relationship by judgment type by lag) repeated measures analysis of variance. The word relationship main effect was significant *F*(1,33) = 26.379, p < 0.001, η2 = .444, which indicated that associative priming, *M* = 0.354, *SE* = .038, was stronger than semantic priming, *M* = 0.249, *SE* = .024. The other main effects and interactions were not significant, all *F*s <1.333. As seen in Figure 2, this finding indicates that amount of priming for semantic and associative word pairs was the same for both judgmental conditions as averaged over lag.

*Latencies*

Latency data was collected from each participant by taking the time from when the judgment pair was redisplayed at the end of the RSVP trial until the participant hit a judgment number key. For each participant, the distribution of judgment latencies was trimmed using a recursive 3 standard deviation elimination method described by Van Selst and Jolicoeur (1994); on average, 3% of the latencies were eliminated for each participant. The remaining latencies were averaged across participants for each judgmental condition for each of the 216 word triplets. Latency differences were found between the semantic and associative judgment conditions, *t*(215) = 12.680, *p* < 0.001. Associative judgments, *M*=3744.92 ms, *SE*=73.14, were significantly faster than semantic judgments, *M*=4907.32 ms, *SE*=79.18. These latency results seem to indicate that associative relationships are judged faster than semantic relationships, and associations may be processed before semantics as indicated in a modified IA model.

One possible interpretation of the priming results is that participants did not fully process word pairs before the judgment task and that is why the judgmental asymmetry was not reflected in the priming data. On this account our participants could have ignored the first word pairs because they were not necessary to complete the RSVP task. If this were the case, then priming should not have occurred in the RSVP task. Yet strong associative and semantic priming was found in the RSVP task, which indicates that participants at least processed the first word pair presented. It may still be the case that participants may have processed the judgment words in an unintended manner. These two possibilities are tested in Experiments 2 and 3. Experiment 2 tested if the judgment word order affected word processing, and Experiment 3 tested if judgment-priming order changed related word priming effects.

Experiment 2

One interesting result from the previous experiment was the overall boost in associative priming over semantic priming. Although both types of words were significantly primed over unrelated word pairs, associative word pairs always show an advantage in priming over semantic word pairs. Experiment 2 was designed to test if the presentation of the judgment pairs was the reason for this advantage in associative pairs. In Experiment 1, the target was related to the top word in the judgment pair. For example, in Figure 1, HORSE-COW is the judgment pair with HORSE presented on the top line above the fixation cross and COW presented on the bottom line below the fixation cross. HORSE-PONY is the prime-target pair, so the top presented word in the judgment pair HORSE is related to the RSVP target word PONY.

The presentation was kept this way to control the relationships of the judgment pairs, since associative relationships change depending on the order in which the words are presented. Experiment 2 was designed to see if the order of the pairs presented changed the nature of priming in the hybrid task. It may be that attention is focused on the top word in the previous experiment, which creates priming because it was the prime word. If attention was focused or anchored to the top word, then placing the prime word on the bottom of the judgment pair would eliminate priming. Priming would be eliminated if it were only attention based because the top word was processed and priming was created from this attentional processing. When the prime word is the bottom word, this attentional priming should not be found, and only automatic priming should be found.

Method

*Participants*

There were 44 participants recruited as described in Experiment 1. A criterion of at least 20 percent correct on the RSVP task was used again in this experiment, which eliminated three participants from the analyses.

*Materials*

A new set of word pairs was created for this experiment. They were created in the same way as described in Experiment 1, with one notable exception. In Experiment 1 the order of the judgment pair was constrained so that the first word (the word on top in the judgment alignment) was the prime of the prime-target pair. This constraint was in place so that the judgment pairs would have a known relationship, since flipping the word order (from top to bottom) would change the associative relationship. For example, BREAD-CRUST have a forward relationship of FSG=.25, but no backwards relationship of CRUST-BREAD (BSG is approximately zero). Therefore, balancing the order of words within Experiment 1 would have been problematic, since it was required that the judgment pairs have a forward relationship. To test if word order changes the nature of priming, a new list of words was created so that the judgment pair included the second (or bottom placed word) as the prime from the prime-target pair. For example, PIG-STY was created for the judgment pair, so that STY-EYE was the associative priming pair. For semantic priming pairs, BANANA-SPLIT was a judgment pair, and SPLIT-TEAR was a priming pair. Table 1 contains the means for these word pairs. This procedure limited the number of word pairs to: 30 associative pairs, 30 semantic pairs, and 60 unrelated pairs, which were split evenly across the semantic and associative judgment block.

*Procedure*

The RSVP task was shortened to three items: two distractors and one target item, therefore SOA was limited to 67ms. In the first experiment, priming was seen equally across all three lags (1, 3, or 6), regardless of judgment condition. Therefore, the longer lags were eliminated to make the procedure simpler and the task shorter. Otherwise, the judgment and RSVP procedures were the same as the previous experiments.

Results and Discussion

*Priming*

Priming was found for each of the word pair types, although there was no difference in priming between associative and semantic word pairs in this experiment. See Figure 3 for the mean differences for word pairs by judgments. A 2 X 2 (word pair relationship by judgment type) repeated measures ANOVA was analyzed on the data, which indicated that neither word type, F<1, nor judgment type, F(1,40) = 2.529, p=.534, nor their interaction, F<1, were significant. Even though there were no differences between word relationship types in priming, all sets of relationships are significantly primed greater than zero: associative words in an associative judgment, t = 12.318, p<.001; semantic words in an associative judgment, t = 12.217, p<.001; associative words in a semantic judgment, t = 14.669, p<.001; and semantic words in a semantic judgment, t = 13.573; p<.001.

*Judgments*

Associative information predicted participant judgments in the associative and semantic judgment conditions, while semantic information only predicted judgments in the semantic judgment condition. Two multiple linear regressions were performed using FSG and JCN to predict word pair ratings. For associative judgments, the associative beta was a significant predictor (β = .241, t = 2.632, p=.010), while JCN was not a significant predictor of word pair ratings (β = .087, t = .946, p=.346). In the semantic judgment condition, both associative information FSG (β = .212, t = .2.366, p=.020) and semantic information JCN (β = -.196, t = -2.194, p=.030) predicted word pair ratings.

*Latencies*

After trimming the latency data for this experiment as described in Experiment 1, associative and semantic judgments were compared for their reaction times. Using a paired sample t-test, reaction times for judgments were significantly different from each other, t(148) = 7.826, p<.001. This difference showed that associative judgments, M= 3348.36, SE=118.18, were made faster than semantic judgments, M=4348.75, SE=130.86.

The order of the presentation of the judgment pairs apparently changed the nature of priming in associative word pairs, but does not change how semantic pairs are processed or judgments are made on pairs. As pairs are read, the word meanings and associations are activated, which causes priming for both types of word. The associative advantage occurred in the first two experiments because the top word was related to the prime in the RSVP stream. When the prime word was presented on the bottom in this experiment, the associative advantage was eliminated. This difference was possibly due to the nature of English reading, which reads top to bottom; therefore, the top word was receiving more processing. This effect was independent of judgments even though the associative judgment condition asks participants to name how many people would have given the SECOND word given the FIRST word.

This result may be due to the direction of attention when the priming word is presented on the top of the judgment pair. This attention component along with an automatic priming component creates a larger associative report rate (Neely, 1991). In this experiment, attention is still directed to the top word in the judgment pair, which is no longer the priming word. Now, only the automatic priming component is seen, so associative word pairs are reported less because they do not have a boost from attentional processing. As seen in the other experiments, associative priming is greater because an attentional component (focusing on the top word) has boosted the processing of that word.

Experiment 3

After testing if word order can change priming for semantic and associative relationships, it was apparent that judgment order could also change the nature of semantic and associative priming. By having participants judge the words after the RSVP task, it was assumed that they were processing the words to make a judgment during the RSVP task. However, it could be that forcing participants to make a judgment at the beginning of the test would cause them to process the word pairs in a different way than just presenting them the pairs to be judged later. Also, by creating a judgment first, judgments may have created the cross over priming effect that is seen in the judgment task. After a judgment, participants may be restricting information flow from the opposing judgment type, which would cause a decrease in priming for the opposite prime-target pair. This effect would create a cross over priming effect as described in the introduction. Two groups were given the hybrid judgment-RSVP task: one with judgments that preceded the RSVP task, and one with judgments that were after the RSVP task.

Method

*Participants*

All participants were recruited as indicated in Experiment 1. There were 25 participants tested in the judgment first group: three were excluded because they performed less than 20 percent in the RSVP task. Also, 24 participants were tested in the judgment second group, and only two were excluded for poor performance with less than 20 percent on the RSVP task. Therefore, 22 participants were analyzed in each group.

*Materials*

The exact same materials as Experiment 1 were used in this experiment and means are presented in Table 1.

*Procedure*

The RSVP procedure was exactly as described in Experiment 2, where a 3-item stream was used with two distractors and one target. Participants in the judgment first condition were told that they would first make a judgment on two words, which was followed by the RSVP stream where they had to watch for a target. The judgment pair was presented on the screen and stayed on the screen until the participant entered their judgment. Immediately after they entered a number for their judgment, the 3-item RSVP stream started. After the RSVP stream was shown, the participant was shown a box where they entered the target word that appeared in the RSVP stream. In the judgment first condition, there was no fixation cross between the words, unlike the first viewing of the words in the judgment second condition. The task for the judgment second group was performed in the exact same way as Experiment 2.

Results and Discussion

*Priming*

Priming for both associative and semantic word types was found, with associative word pairs receiving more priming than other pairs. Judgments did not affect priming, as with previous experiments, nor did judgment placement affect priming for word pairs. A 2 X 2 X 2 (word relationship type by judgment type by judgment placement) mixed design ANOVA was analyzed on this data set. See Figure 4 for the mean differences of both groups by judgment and word type. The word type main effect was significant F(1,42) = 98.898, p<.001, η2 = .704, indicating that associative priming, M = .456, SE = .026, was significantly more than semantic priming, M = .275, SE = .020. The word by group interaction approached significance, F(1,42) = 3.656, p=.063, probably because of the slight decline in priming from associative to semantic judgments in the judgment first group and a slight incline in priming from the semantic to associative judgments in the judgment second group (i.e. there is a cross over pattern across groups). Judgments and the rest of the interactions were non-significant with Fs<1.

*Judgments*

In this experiment, judgments were only predicted by associative information in both the semantic and associative judgment conditions and semantic information did not predict participant scores. Two multiple linear regressions were again performed using FSG and JCN to word pair ratings. Associative information (FSG) predicted word pair ratings in both the associative judgment condition (β = .411, t = 6.584, p<.001) and the semantic judgment condition (β = .296, t = 4.511, p<.001). Semantic information did not significantly predict word pair ratings in either the associative judgment condition (β = .100, t = 1.595, p=.112) or the semantic judgment condition (β = -.023, t = -.355, p=.723). This result was the same even if regressions were used to predict word pair ratings for each individual group.

*Latencies*

The reaction times were trimmed in the same procedure that is described in Experiment 1. In the judgment first condition, reaction time differences were not found, t(237) = .896, p=.371. Associative judgments, M=4917.70, SE=121.99, were not significantly different from semantic judgment reaction times, M=4822.69, SE=113.81. The judgment second condition showed a different pattern of results. As with the other experiments, a significant difference between the two judgment types was found, t(237) = 6.604, p<.001. Associative judgments, M=3244.02, SE=79.24, were significantly faster than semantic judgments, M=3896.46, SE=103.95.

This experiment showed that the associative advantage over semantic words in priming was not due to judgment placement and was probably independent of judgments. Priming, in general, also seemed to be independent of judgments, showing the same effect of priming regardless of judgment placement. Associative information was primed more than semantic information regardless of judgment type, which may indicate that associative information was processed earlier than semantic information, since it was always used in both the judgment and priming tasks. Again, associative information was used to judge both associative and semantic word relationships, but semantic information did not seem to be used to predict participants’ judgment scores. This finding was a bit odd considering both the task and word pair sets have been used previously, but possibly are due to a tendency to pick a small range of “relatedness” on the semantic judgment scale. Restriction of judgments to this range would cause that variable to be non-significant during a regression analysis.

Regardless, these sets of experiments showed how associative and semantic information can be separated and priming was significantly strong for both of them. Also, associative judgments were found to be faster than semantic judgments in the judgment second condition. Once associative information is activated, it may add to the ability for people to make judgments on those word pairs. However, activating and judging semantic relationships takes longer to perform and requires the use of associative information. From here though, these results raise the question where associative information was processed through the system. Since priming effects are shown to be separable, where should an associative store of information be placed and how does that information get processed?

General Discussion

These experiments were designed to answer a couple of questions about the nature of semantic and associative memory. While this topic has been researched before, there have been some methodological problems with previous studies. First, many studies have used self-selected word pair stimuli that participants normed as part of the experiment as “purely” semantic word pairs or words with both relationships to study the associative boost. However, as explained earlier, there are multiple databases of semantic and associative word pairs, which have shown to measure separate types of information (Maki & Buchanan, 2008). The experiments presented here made use of these databases to create separate, orthogonal word pairs to test only semantic and associate priming, with two purposes.

First, several experiments were designed to test the nature of both semantic and associative priming when they are separate from each other. The judgment data indicated that associative judgments are only predicted by associative information and that semantic judgments are predicted by both semantics and associations. Second, both associative and semantic priming were found, which indicated that these relationships could be separated from each other. Latency data on these judgments also showed that there was something separate about associative and semantic judgments; associative judgments were consistently faster than semantic judgments.

Since these relationships were found to be separable, it led to a second question about where an associative memory store would be placed in memory models. One current model of memory, that also explains priming, is McClelland and Rumelhart’s (1981) IA model (Stolz & Besner, 1996). However, the IA model does not have a good description of where associative information would be stored. Williams (1996) has proposed an “inter-lexical” hypothesis for associative or common occurrence links that stated that information would be stored at the lexical or word level. Since associative information is stored at the word level, priming from associative relationships would always occur because to identify the word would automatically bring up links between the words. Also, associative information could not be restricted or blocked when word identification was necessary because they are stored in the same level.

Judgments of semantic and associative memory can also be partially understood from these models. This model would predict that during an associative judgment task, only associative information should be important when making those judgments because the semantic store is not necessary and is therefore ignored. During a semantic judgment task, both associative information and semantic information should be involved in making judgments because the information flows back down from the semantic store and associative information is already present in the lexical level. Latencies would also show a similar prediction of results. Associative judgments should be faster than semantic judgments because semantic processing is not necessary for associative judgments. After processing at the lexical level, an associative judgment can be made. Semantic judgments would take longer due to an extra processing level.

In Experiment 1, priming for semantic and associative pairs was found above unrelated word pairs in the RSVP task regardless of judgment type. These results answered the first question about the nature of separate priming. It was not necessary to have both relationships for priming of either associative or semantic relationships to occur. The same amount of priming for associative word pairs was seen in both the semantic and associative judgment conditions. Judgments had a lopsided pattern of information use, where associative information predicted both associative and semantic judgment conditions while semantic information only predicted semantic judgment conditions. Finally, associative judgments were faster than semantic judgments, altogether which supports the modified IA model because associative information cannot be blocked or ignored, which may have indicated associative information was stored at a word level.

Experiment 2 tested if the order of the judgment pairs made a difference in priming and judgments using the RSVP and judgment task. A new set of word pairs was tested so that the order of the judgment pair could be reversed. Originally, the top word in the judgment pair was related to the target word in the RSVP stream. Here, the order of the pairs was flipped so that the bottom word was now related to the target in the RSVP stream; otherwise the RSVP and judgment task remained the same. This experiment found interesting results because it was the only time that associative priming was not found to be significantly reported more than semantic priming. However, both relationship types were primed more than unrelated word pairs.

After testing for word order of the judgment pairs, Experiment 3 was tested to examine if judgment placement could change priming. In one condition, participants judged priming words before the RSVP stream, while other participants judged priming words after the RSVP stream. Both groups showed significant priming over unrelated word pairs and significant associative priming over semantic priming. There was no difference between the two groups, so priming words, which were part of the judgment pair, just need to be seen to create priming. Judgment data only partially replicated previous results. Associative information predicted word pair ratings in both the associative and semantic conditions, while semantic information did not predict word pair ratings. While this result was a bit odd considering all previous findings, it did not disconfirm model predictions. Semantic information may have been ignored or blocked, which is a restriction of the downward arrows in any of the model predictions. The consistent findings of strong associative priming and an inability to restrict or block associative information during any judgment or priming task favors the suggested IA model.

After several different tests on the combined RSVP and judgment task, it was clear that other manipulations of judgments or word pairs would produce basically the same results. Associative priming was always found to be very strong, and usually stronger than semantic priming. There can be no question about the answer to priming and word pair relationships. Associative and semantic priming are indeed separate entities, and while dual relationships can help priming, they are not necessary to create enhanced identification for related words. Both types are shown to prime in a newer paradigm of priming with the RSVP task and a tradition lexical decision task experiment. Finally, a model with associative information stored at the lexical level was suggested. This model posits that associative information should always primed, judged faster than semantic information, and should always predict memory judgments. All three of these results were found, which indicates that this model may be a acceptable definition of how associative and semantic information are separately stored.

References

Buchanan, E., Maki, W. S., & Patton, M.  (2007).  Associative judgments block semantic

processing …Poster submitted for presentation at the Psychonomic Society

meeting, Long Beach, November, 2007.

Collins, A., & Loftus, E. (1975). A spreading-activation theory of semantic processing.

*Psychological Review, 82*(6), 407-428.

Davenport, J., & Potter, M. (2005). The locus of semantic priming in RSVP target search.

*Memory & Cognition, 33*(2), 241-248.

Hutchison, K. (2003). Is semantic priming due to association strength or feature overlap?

A microanalytic review. *Psychonomic Bulletin & Review, 10(*4), 785-813.

Hutchison, K., & Bosco, F. (2007). Congruency effects in the letter search task: Semantic

activation in the absence of priming. *Memory & Cognition, 35*(3), 514-525.

Jiang, J. J., & Conrath, D. W. (1997). Semantic similarity based on corpus statistics and

lexical taxonomy. In Proceedings of International Conference Research on

Computational Linguistics (ROCLINGX), Taiwan.

Maki, W. (2007a). Judgments of associative memory. *Cognitive Psychology, 54*(4), 319-

353.

Maki, W. (2007b). Separating Bias and Sensitivity in Judgments of Associative Memory.

*Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(1),

231-237.

Maki, W. & Buchanan, E. (2008). Latent structure in measures of associative,

semantic, and thematic knowledge. *Psychonomic Bulletin & Review, 15,* 598-603.

Maki, W., Frigen, K., & Paulson, K. (1997). Associative priming by targets and

distractors during rapid serial visual presentation: Does word meaning survive the attentional blink?. *Journal of Experimental Psychology: Human Perception and Performance, 23*(4), 1014-1034.

Maki, W., Krimsky, M., & Muñoz, S. (2006). An efficient method for estimating

semantic similarity based on feature overlap: Reliability and validity of semantic

feature ratings. *Behavior Research Methods, 38*(1), 153-157.

Maki, W., McKinley, L., & Thompson, A. (2004). Semantic distance norms computed

from an electronic dictionary (WordNet). *Behavior Research Methods, Instruments & Computers, 36*(3), 421-431.

McClelland, J., & Rumelhart, D. (1981). An interactive activation model of context

effects in letter perception: I. An account of basic findings. *Psychological Review,*

*88*(5), 375-407.

McRae, K., Cree, G., Seidenberg, M., & McNorgan, C. (2005). Semantic feature

production norms for a large set of living and nonliving things. *Behavior Research Methods, 37*(4), 547-559.

Meyer, D., & Schvaneveldt, R. (1971). Facilitation in recognizing pairs of words:

Evidence of a dependence between retrieval operations. *Journal of Experimental*

*Psychology, 90*(2), 227-234.

Neely, J. (1991). *Semantic priming effects in visual word recognition: A selective review*

*of current findings and theories*. Hillsdale, NJ, England: Lawrence Erlbaum

Associates, Inc.

Nelson, D., McEvoy, C., & Schreiber, T. (2004). The University of South Florida free

association, rhyme, and word fragment norms. *Behavior Research Methods,*

*Instruments & Computers, 36*(3), 402-407.

Smith, M., & Besner, D. (2001). Modulating semantic feedback in visual word

recognition. *Psychonomic Bulletin & Review, 8(*1), 111-117.

Stolz, J., & Besner, D. (1996). Role of set in visual word recognition: Activation and

activation blocking as nonautomatic processes. *Journal of Experimental Psychology: Human Perception and Performance, 22*(5), 1166-1177.

Stolz, J., & Besner, D. (1999). On the myth of automatic semantic activation in reading.

*Current Directions in Psychological Science, 8*(2), 61-65.

Tulving, E. (1993). What is episodic memory?. *Current Directions in Psychological*

*Science, 2*(3), 67-70.

Van Selst, M., & Jolicoeur, P. (1994). A solution to the effect of sample size on outlier

elimination. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology, 47*(3), 631-650.

Vinson, D., & Vigliocco, G. (2008). Semantic feature production norms for a large set of objects

and events. *Behavior Research Methods*, *40*(1), 183-190.

Williams, J. (1996). Is automatic priming semantic? *European Journal of Cognitive*

*Psychology, 8*(2), 113-161.

Table 1. *Means for Associative and Semantic Variables in all Experiments.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | FSG |  | BSG |  | JCN |
| **Associative Judgment Pairs** | Experiment 1/3 | 0.075 |  | 0.007 |  | 15.456 |
|  | Experiment 2 | 0.058 |  | 0.065 |  | 22.353 |
| **Semantic Judgment Pairs** | Experiment 1/3 | 0.122 |  | 0.014 |  | 12.435 |
|  | Experiment 2 | 0.051 |  | 0.092 |  | 19.946 |
| **Unrelated Judgment Pairs** | Experiment 1/3 | 0.105 |  | 0.033 |  | 12.108 |
|  | Experiment 2 | 0.100 |  | 0.036 |  | 11.913 |
| **Associative Priming Pairs** | Experiment 1/3 | 0.573 |  | 0.011 |  | 20.582 |
|  | Experiment 2 | 0.543 |  | 0.012 |  | 20.935 |
| **Semantic Priming Pairs** | Experiment 1/3 | 0.023 |  | 0.006 |  | 0.186 |
|  | Experiment 2 | 0.014 |  | 0.007 |  | 0.236 |
| **Unrelated Priming Pairs** | Experiment 1/3 | 0.000 |  | 0.000 |  | 32.000 |
|  | Experiment 2 | 0.000 |  | 0.000 |  | 32.000 |

*Note.* FSG and BSG are scaled from 0.00 – 1.00 where 1 indicates a strong associative relationship. JCN is scaled from 0.00 – 32.00 where 0.00 indicates complete semantic similarity.

Figure Captions

*Figure 1.* Representation of the judgment and RSVP task for Experiment 1.

*Figure 2.* Accuracy in the RSVP task by judgment condition and lag. Accuracy is presented as related word pair proportion correct of each word type subtracted by unrelated word pair accuracy for each lag.

*Figure 3.* Mean differences in priming proportion for associative and semantic word pairs by judgment type for Experiment 2 in the RSVP task.

*Figure 4.* Mean differences in priming proportion for both the judgment first and the judgment second groups by word type and judgment type for Experiment 3.

|  |
| --- |
| horse  +  cow  **67 ms**  **Time**  **67 ms - Target**  **1000 ms – Judgment Pair**  0?&^7\*59  48$&0^51  pony  ?7>86&%0  **67 ms**  **67 ms**  **…**  Word Entry  horse  cow  **Judgment** |

*Figure 1.*

|  |
| --- |
|  |

*Figure 2.*

|  |
| --- |
| *Figure 3.* |

|  |
| --- |
| figure11 |
| *Figure 4.* |