SEMANTIC ACTIVATION WITHOUT AWARENESS: STILL NO RELIABLE EVIDENCE

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ABSTRACT

Three experiments were conducted to examine whether semantic association contributes to unconscious priming. Experiment 1 used exclusion instructions in which participants were told to avoid completing the stem (e.g. *mo*---) with a word related to a masked prime (e.g. *cash*) flashed for 0, 38, or 212 ms. Significant semantic priming was found only in the items analysis when data was averaged across participants. In the subjects analysis, this performance was moderated by participants' ability to report the prime. Experiment 2 used a free association task to examine unconscious semantic priming. Participants were instructed to respond to a target homograph (e.g. *pupil*) with the first word that came to mind that is not related to the meaning of the flashed word (e.g. *student*). No significant unconscious semantic priming was found. Experiment 3 replicated the conditions previously used to demonstrate unconscious semantic priming and show that such priming is due to methodological problems. The same methodology as Experiment 2 was used except participants were given inclusion instead of exclusion instructions. Significant priming was found across all trials; however, this priming dissolved when only the trials where participants failed to report the prime were examined. The results of all experiments suggest that unconscious semantic priming from word stimuli is a result of residual conscious awareness of the prime.

CHAPTER 1

INTRODUCTION

Subliminal perception is one of the rare topics in psychological research that has had a long history of representation in the media. The topic was injected into the popular consciousness in 1957 when an advertiser briefly flashed the words “eat popcorn” and “drink coca-cola” during the previews of a movie (Key, 1973). Although later discredited as a hoax, the owner claimed that the messages significantly increased concession sales. Some 20 years later, the advertising industry turned its focus to children. In response to a toy commercial which contained the briefly flashed words “Get it”, the FCC issued a regulation stating that subliminal methods, regardless of effectiveness, were contrary to public interest due to their deceptive nature. Nonetheless, the technique is still being used. During the last election, the Republican Party ran a commercial criticizing the Gore campaign containing a brief presentation of the word “RATS” during a reference to the Democratic Party. Despite popular excitement over such controversies, the nature of unconscious perception is still undetermined and the scientific community still continues the debate concerning the nature of unconscious perception (Merikle & Daneman, 1998).

CHAPTER 2

BACKGROUND

Although research in the field spans over a century, there are still important unanswered questions regarding how information presented below the level of awareness can influence people's overt behavioral responses. There are a large number of publications that serve as evidence for the phenomenon (see Merikle, Smilek, & Eastwood, 2001, for a review). Recent research in the field has focused more on the level at, and processes by, which unconscious perception occurs. The most common assumption is that unconscious perception can occur semantically (Abrams, Klinger, & Greenwald, 2002; Balota, 1983; Fowler, Wolford, Slade, & Tassinary, 1981; Marcel, 1980; Ortells, Daza, & Fox, 2003; Ruz, Madrid, Lupianez, & Tudela, 2003). Proponents of this perspective propose that information related to the meaning of a word can be processed in the absence of conscious awareness of the word's lexical or semantic representation. This account has been demonstrated through variations of the masked semantic priming paradigm, in which a target is preceded by a briefly presented related word and immediately followed by a backward mask (see Forster, 1998, for a review). Priming is said to occur in this paradigm as a result of the unconscious activation and spread of the prime's meaning to the related target word (Collins & Loftus, 1975). Others have applied a response competition model to explain masked priming effects in specific paradigms in which classification tasks are used and relatedness is confounded with response competition (Klinger, Burton, & Pitts, 2000). Still, other researchers have

claimed to account for unconscious effects traditionally assumed to be semantic or lexical by sub-lexical perceptual activation (Abrams & Greenwald, 2000; Hutchison, Neely, Neill, & Walker, 2004; Kouider, & Dupoux, 2004; Masson and Isaac, 1999). Methodological differences between experimental paradigms serve as the source of much disagreement concerning the nature of unconscious perception. Merikle et al. (2001) outlined four major approaches that have been used to study unconscious perception. According to this taxonomy, almost all studies can be classified with respect to the experimental logic (dissociations vs. qualitative differences) and the methodology (distributed attention vs. stimulus conditions) used to manipulate awareness of the stimuli. The majority of studies on unconscious perception have employed some version of the task dissociation procedure (Merikle & Reingold, 1998).

The Task Dissociation Procedure

The basic principle underlying the task dissociation procedure is that unconscious perception can be demonstrated by dissociating direct (conscious) influences from indirect (unconscious) influences. A direct measure is an overt response made by the participant indicating whether or not he or she perceived the stimulus. The indirect measure is meant to reflect the unconscious effect of the stimulus on the participant's behavior [such as facilitation in a lexical decision task in which the participant makes a word/non-word judgment]. According to the task dissociation procedure, if an indirect effect can be demonstrated in the absence of a direct effect (awareness of prime), then

there is evidence of unconscious perception. Sidis (1898) conducted one of the first studies in unconscious perception and utilized a version of the task dissociation procedure in order to putatively demonstrate perception without awareness. Sidis showed participants cards printed with either a number or a letter. He manipulated the distance of the cards from the observer to the point at which participants reported an inability to perceive the information on the card (direct measure). He then instructed participants to guess whether the card contained either a letter or a number (indirect measure). Sidis found that participants were able to guess not only the category of the card, but also were able to report the identity of the letter or number above the level of chance. He interpreted this as evidence for unconscious perception; however, there are problems with this conclusion. Debner and Jacoby (1994) suggested that the degree to which residual conscious effects boost priming in the indirect task is unknown. With respect to the majority of contemporary studies using masked priming, it has been demonstrated that the partial awareness of the prime and the presentation of a related target may provide additional information allowing the participant to guess the identity of the prime (Hutchison et al. 2004). In the traditional task dissociation paradigm, this partial conscious awareness may produce the illusion of subliminal priming in the indirect task

The Task Dissociation Procedure and Its Discontents

Over a century has passed and the same problems that troubled the Sidis study are still relevant. For example Forster, Booker, Schacter, and Davis (1990) used a similar version of the task dissociation procedure to explore unconscious priming in a stem completion task. Forster et al. (1990) asked participants to complete a word stem (e.g., win---) with the first word that came to mind after the presentation of a briefly flashed prime (60 ms). Participants completed the stem with the target (e.g., window) 15% of the time when the prime was unrelated (e.g., pencil) but this increased to 27% when the prime contained similar orthographic and phonological features (e.g., minnow) and to 33% when participants were presented with an identity prime (e.g., window). As a result, Forster et al. (1990) concluded that identity or word level effects can occur under masked prime conditions; however, the degree to which conscious processes influenced this finding is still unknown.

One of the most obvious problems with the task dissociation procedure is that most studies rely on a practice session to determine the level of stimulus intensity at which a participant performs at chance on an identification task (Holender, 1986). This level has been referred to as the *threshold* of conscious awareness. Primes presented near or at this assumed threshold are often used as unconscious primes in the experimental phase. This is a problem because the concept of a definite threshold of awareness is questionable (Erdelyi, 2004; Haase & Fisk, 2001; Haase, Theois, & Jenison, 1999). According to Erdelyi, the threshold of awareness may shift over time and vary by

task and participant. Furthermore, it is possible that participants can detect unconscious primes at very short durations. Individual differences in ability to detect the prime and the indeterminacy of a specific threshold of awareness are central issues regarding research in unconscious perception. Specifically, much of the controversy centers on the validity of a paradigm that unequivocally demonstrates an indirect effect without a direct effect. To demonstrate such a pattern, it is crucial to have a valid paradigm that sufficiently measures and disqualifies the effects of conscious perception. The application of a methodology that excludes the contamination of conscious effects on the indirect measure has remained elusive and studies that have claimed to demonstrate it (Fowler, et al, 1981; Marcel, 1983) have been the focus of much criticism (Holender, 1986; Merikle, 1982; Nolan & Caramazza, 1982). In fact, recent research by Kouider and Dupioux (2004) has shown that semantic unconscious priming may be attributed to the partial awareness of the primes. Furthermore, in a modification of the Forster et al. (1990) stem completion experiment, Hutchison et al. (2004) found that participants were more likely to consciously identify a flashed prime (e.g., window) when it preceded an identity-related stem (e.g., win---) than when it preceded a form-related stem (e.g., sha---). This suggests that the presence of the identical stem provided enough information for the participants to reconstruct the degraded stimulus information from the masked prime. Thus, measures of direct awareness may greatly underestimate the contribution of conscious processes under supposed indirect or unconscious priming conditions. Given these problems, it is difficult to interpret results of studies that report

unconscious semantic priming because these effects may be a result of conscious and unconscious processes working in conjunction to produce the illusion of unconscious semantic priming.

An Alternative Methodology

Jacoby (1991) used an alternative methodology to explore the boundary between conscious and unconscious processes. The process dissociation procedure was originally developed to unravel the contributions of automatic and controlled mechanisms in memory: specifically, recollection and familiarity. It has more recently been applied to studies of unconscious perception (Debner & Jacoby, 1994; Hutchison et al., 2004; Merikle, Joordens, & Stoltz, 1995). To separate the influences of automatic and controlled mechanisms, the process dissociation procedure uses inclusion and exclusion instructions. Under inclusion instructions, participants are told to use the previously presented prime (e.g., tiger) to help respond to a target stem (e.g., ti---). Under exclusion instructions, participants are instructed to complete the task without using the information presented in the prime (e.g., timid). The exclusion condition provides a conservative estimate of the contribution of unconscious priming by placing conscious contributions to a response in opposition to unconscious effects. This procedure thus ameliorates one of the most pressing problems associated with the TDP: the contribution of conscious processes to unconscious priming. Debner and Jacoby (1994) employed this methodology to tease apart the influence of unconscious and conscious components in a

stem completion task. In their exclusion condition, Debner and Jacoby found that participants completed the stem with the target on 34% of the trials after an unrelated prime was flashed. When an identity prime was flashed for 500ms (long enough for the prime to consciously identified), this percentage dropped to 10%. Thus, participants were usually following the exclusion instructions and avoided completing the target with the flashed prime when it could be identified. Importantly, when an identity prime was flashed for only 50ms, participants completed the stem with the flashed prime 50% of the time. This 16% increase in stem completion over the unrelated baseline condition occurred despite the conscious attempt to avoid using the flashed word.

Perceptual vs. Semantic Priming

Debner and Jacoby (1994) found significant priming in an exclusion condition, which is an extremely conservative measure of unconscious priming because any residual conscious effect would oppose priming. These results strongly support the existence of unconscious perception; however, the level at which identity priming occurs is still unclear. The 16% identity priming effect they found could be accounted for by the complete overlap of phonological and orthographic (perceptual) information between identical primes and targets (Hutchison et al., 2004).

Because the identity priming effect found by Debner and Jacoby (1994) and Forster et al. (1990) could be a result of the shared influence of phonological and orthographic activation rather than unconscious activation at the lexical or semantic level,

Hutchison et al. (2004) employed the exclusion task in conditions in which the target stem completion was related to the prime (e.g., window) either by identity (e.g., win---) or form (e.g., sha---). Hutchison et al. improved upon the previous methodology by instructing participants to report whether or not they saw the prime on a trial by trial basis (as suggested by Holender, 1986). This on-line prime report provides a more valid indication of participants' compliance to the exclusion instructions and a more precise indicator of unconscious priming by allowing the researcher to exclude the specific trials where participants were able to report the prime. The online prime report coupled with the exclusion instructions was proposed as a way to resolve the most persistent problem with research in unconscious perception: Conscious awareness of primes may shift over time, across participants, and from item to item.

The results of the Hutchison et al.'s (2004) study suggest that the identity priming found in the Debner and Jacoby (1994) and Forster (1990) studies could be entirely explained by the combined contribution of orthographic and phonological information. Therefore, semantic information related to masked stimuli may not be processed unconsciously at the whole word level. This conclusion has recently been supported by other researchers (Abrams & Greenwald, 2002; Koudier & Dupoix, 2004; Masson & Isaac, 1999).

The claim that identity priming could primarily be a result of sub-lexical activation is troublesome for the studies suggesting that semantic information regarding a word can be processed unconsciously (Balota, 1983; Fowler, et al, 1981; Marcel, 1980). The findings are a problem because it is hard to imagine a system in which semantic

information related to a word can be processed without some level of representation of the identity of the word. In fact, such a hierarchical concept is standard among models of word recognition (Besner & Smith, 1992; McClelland, 1987; McClelland & Rumelhart, 1981). According to such models, a word is first analyzed at the feature level, and activation proceeds via a bottom-up process leading to the activation of the word, then to that word's corresponding semantic representation. Holender's (2004) single process view of perception offers a similar perspective. In Holender's view, "There [are] doubts about whether the result of processing….referred to as semantic activation, would not generate conscious mental contents involving the identity and the meaning of the stimulus, referred to as conscious identification" (p. 877). The methodological problem underlying the controversy of unconscious semantic priming is ultimately linked to the nature of subjective human experience and its relation to scientific inquiry. It is a question of the degree to which we can rely on participants' subjective claims of awareness, or objective performance on a direct task, as indicators of the actual level of awareness of a stimulus.

CHAPTER 3

THE CURRENT INVESTIGATION

The extant research leads us to a point of contention. If sub-lexical perceptual processes can entirely account for unconscious priming (Hutchison et al., 2004, Masson & Isaac, 1999), then there may be something flawed in the methodology that has been used to demonstrate unconscious semantic priming (Holender,1986; Holender & Duscherer, 2004). However, the wealth of data that support the unconscious semantic perception hypothesis warrants further attention. The present research adopts solutions to previous methodological problems associated with the TDP in a paradigm that explores the nature of unconscious semantic priming when it is isolated from the contamination of sub-lexical priming and conscious influences.

Goals of Present Study

Three experiments were conducted in order to explore the possible contribution of semantic relatedness in an unconscious priming paradigm. There are two main goals of the present study: provide evidence for or against unconscious semantic priming, and determine the nature of these effects based on participant and stimulus characteristics. If semantic priming is found in a paradigm that excludes the contribution of orthographic and phonological information, it would suggest that the processing of semantic information occurs prior to conscious awareness as suggested by late selection theories of

attention (Deutch & Deutsch, 1963). On the other hand, if there is no demonstration of reliable unconscious semantic priming, it may suggest that attention is required in order to process the meaning of a stimulus (Broadbent, 1958). In this view, perceptual information may be processed without awareness but semantic processing may require attention (Holender, 2004).

The second goal was to determine the specific individual characteristics or characteristics of stimuli that may predict unconscious semantic priming (if valid). It may be that the stimuli must meet certain requirements in order to produce unconscious semantic priming. With the development of measures of semantic or associative relatedness such as Landauer's Latent Semantic Analysis (Landauer, Foltz, & Laham, 1998) and the Nelson word association norms (Nelson, McEvoy, & Schreiber, 1998), it is possible to explore in detail the nature of unconscious semantic priming, assuming that it is a valid phenomenon. The following list of 10 prime target relations and stimulus characteristics were explored: forward association strength, backward association strength, mean association strength, LSA values (Landauer et al., 1998), associative fan-out, associative fan-in, number of possible stem completions, target length, prime length, and prime orthographic neighborhood.

Stimulus Characteristics

Forward and backward association strengths were taken from the Nelson et al. (1998) norms. Forward association strength is the probability that the target word will be given as a response ("the first word that comes to mind") to a prime. Backward association strength refers to the probability that the prime will be produced as a response given the target word. The mean association strength is the average backward and forward association strength. LSA prime target co-occurrence values were retrieved from the LSA website (http://lsa.colorado.edu/). LSA co-occurrence values are extracted through the analysis of large bodies of text and are thought to represent a global estimate of semantic similarity. Associative fan-out refers to the number of associations produced by the presentation of the prime in the Nelson et al. (1998) norms, and fan-in refers to the number of times the target stem completion was given as a response. Values for orthographic neighborhood were taken from the English Lexicon Project (Balota, Cortese, Hutchison, Neely, Nelson, Simpson & Treiman, 2002). Orthographic neighborhood refers to the number of words that can be produced by replacing one letter of the word with another while maintaining position of all other letters. The number of possible completions was taken from the MRC psycholinguistic database (Coltheart, 1981). Target length and prime length refer to the number of letters in the word.

CHAPTER 4

EXPERIMENT 1

The first experiment sought to replicate semantic priming found in previous studies (Balota, 1983; Marcel, 1981) while controlling for contamination of conscious influence. The methodology employed by Hutchison et al. (2004) was adopted using a stem completion task as the indirect measure.

Method

Primes that share only a semantic relationship with the target stem completion were presented at durations of 0 ms, 38 ms, and 212 ms. Each stem had at least 3 possible completions with an overall mean of 25 possible completions across all stems. The 0 ms condition served as a baseline and the 212 ms condition served as a compliance check to ensure that the participants followed exclusion instructions. To determine whether or not the participants saw the prime, they were instructed to perform a trial-by-trial prime report in which they were instructed to “report the prime if they saw it”.

Design

Each stem (mo---) was preceded by a masked prime (cash) related to the meaning of the target stem completion (money). The primes were presented for 0, 38, or 212 ms. Stem completion rates and prime identification was reported from the 3 within-

participants conditions (0, 38, and 212 ms). Unless otherwise noted, a paired-samples t test ($p < .05$) was conducted to test for the main priming effect across the baseline and 38 ms condition.

Stimuli

The MRC psycholinguistic database (Coltheart, 1981) was consulted to select 108 words that had at least 3 possible valid stem completions. Primes were selected by taking the strongest forward (prime to target) associations according to the Nelson norms (Nelson et al, 1998). Three different lists were constructed and items were counterbalanced across durations (0, 38, and 212 ms). This produced 36 observations per condition. To minimize practice effects, the 0, 38, and 212 ms conditions were randomly presented for the 108 trials.

Procedure

Participants were tested one at a time in an isolated room and were seated at a standard distance from a computer screen. Instructions were verbally reported to the participant and also provided on the computer screen. E-prime (Schneider, Eschman, & Zuccolotto, 2001) was used to construct a series of trials in which a centrally positioned 500 ms fixation point preceded a forward pattern mask (500 ms). After the forward mask, the prime appeared for either 0 (no prime), 38, or 212 ms. The prime was then immediately followed by a backward mask. Following a variable inter-stimulus interval (300 ms, 262 ms, 88 ms), participants were presented with a word stem. The variable

interstimulus interval was used to maintain a stimulus onset asynchrony of 300 ms. Upon presentation of the word stem, participants reported the flashed word if they saw it. Participants were then instructed to complete the stem with the first word that came to mind that was not related to the meaning of the flashed word. They were instructed that if they did not see the prime, they should complete the stem with the first word that came to mind. Participants could proceed when ready and were instructed to begin each trial by pressing the "s" key. To be sure participants understood the nature of the exclusion task and the general instructions, each participant was given a series of 10 practice trials with the experimenter present to clarify any problems.

Participants

Sixty Montana State University undergraduates participated for credit in requirement of an introduction to psychology class. All participants had normal or corrected to normal vision and were native English speakers.

Results

Data from three participants were removed for giving random responses or not following exclusion instructions. Effects were computed using a two tailed t test.

Prime Identification

In the 212 ms condition, participants correctly identified the prime on 96% of the trials, suggesting that participants were either unable to retrieve the prime or simply not paying attention on 4% of the trials. In the 38 ms condition, participants were able to report the identity of the prime on 16% of the trials. On the trials that participants were able to identify the primes, the stem was completed with the target word only 5% of the time, suggesting that participants were able to follow exclusion instructions. To test whether or not prime characteristics could predict prime identification, correlations were computed between prime identification (38ms) and the following: prime length, orthographic neighborhood, and frequency of prime.

The present study did not find a significant correlation between prime length and prime identification. However, this null correlation may be a result of the restriction in range of prime length in the present study since 70% of the primes were between 4 and 6 letters long. Neither orthographic neighborhood nor word frequency of the prime was found to predict prime identification, all $r\ (106) < .08$, $p > .35$. Taken in summary, these results suggest that the characteristics of the prime do not predict identification at a very short duration (38 ms) when participants are engaging in an exclusion task.

To examine whether participants engaged in a retrospective process using the information presented in the target stem to reconstruct the prime, Pearson r correlations

between Nelson values (forward, backward, mean), LSA values and prime identification were computed. No significant relationship was found, all $r(106) < .11$, $p > .20$.

Overall Target Stem Completion

In the baseline condition (0 ms) the stem was completed with the target 18% of the time. This percentage was reduced to 5% in the 212 ms condition suggesting that participants could follow the exclusion instructions. In the 38 ms condition the percentage of target stem completions did not change from baseline (18%) producing no significant priming, $t(57) = .190$, $p = .85$.

Target Stem Completion Following Prime Report Failure

To assess unconscious semantic priming, only the trials on which participants failed to report the prime were analyzed. Participants completed the stem with the target word 18% of the time in the baseline condition. This percentage increased to 20% in the 38ms condition, suggesting that participants were more likely to complete the stem with the target word when the related prime was briefly presented. However, this 2.0% ± 3% (95% confidence interval) difference was not significant, $t(56) = 1.52$, $p = .135$, $d = .20$.

To test the stimulus characteristics that predict priming, target stem completion data for each item was averaged across all participants. Stem completion (following prime report failure) in the baseline condition was compared to the 38ms condition producing a significant priming effect of 3.2% ± 2%, $t(107) = 3.249$, p

<.002, d = .16. All 10 of the above mentioned possible predictors of priming (except for "fan-in" values) produced no significant correlations, all r (106) < .12, p > .25. "Fan-in" values were marginally correlated with priming, r (106) = -.18, p = .06, indicating that higher frequency responses given in the Nelson norms were less likely to be used to complete the stem than low frequency responses.

Participants' ability to detect the prime in the 38ms condition was aggregated and averaged across trials. A tertiary split was conducted by participants' ability to report the prime. The top third (in prime report percentage) was compared to the bottom third on their susceptibility to priming. Individual ability to detect the prime was found to be negatively associated with priming. Participants who performed well in reporting the prime only showed priming of -1% whereas those who did not perform well demonstrated priming of 8%. An independent- samples t test was conducted on this difference. Participants who were in the top third on prime identification performance were significantly less susceptible to priming than the bottom third, t (37) = 2.75, p = .009, indicating that participants who are more likely to demonstrate priming are also less likely to report the identity of a prime in the 38ms condition.

Discussion

The results of Experiment 1 indicate significant priming when the data are aggregated by items and averaged across all participants; however, no significant priming is found when the data are aggregated by participants and averaged across items.

Individual differences may account for this discrepancy. Some participants show strong priming effects whereas others do not, and when averaged across items, these individual differences may minimize the ability of the subjects analysis to reveal priming. Experiment 1 leads to the tentative conclusion that unconscious semantic perception may be an artifact of the experimental design and participants' individual differences in ability to report the prime. This conclusion is strengthened by the lack of correlation between prime-target characteristics and priming. I found no relation between any of the plausible predictors that one would expect to be related to unconscious semantic activation (specifically semantic associative strength or contextual similarity); however, individual differences in participants ability to report the prime were significantly related to priming. The results of Experiment 1, coupled with the findings of Hutchison et al. (2004) and others, suggest that unconscious semantic activation may not be a reliable phenomenon and support single-process models of perception (Holender, 2004) and similar early selection theories of attention (Broadbent, 1958).

CHAPTER 5

EXPERIMENT 2

The lack of reliable priming in the participant analysis, along with the significant priming found when data were aggregated by items in Experiment 1, warranted further research. The same overall methodology was used in Experiment 2; however, a free association task to a target homograph was used as the indirect measure instead of a stem completion task. The free association task was implemented for two reasons: it is thought to be more sensitive to semantic information than the stem completion task; the task provides a way to measure both identity and semantic priming effects.

Method

Design

Each homograph (pupil) was preceded by a masked prime (student or eye) that was related to either of the homograph's meanings. The primes were presented for 0, 38, or 212 ms. Identity priming and associative semantic priming results were reported from the 3 within-participants conditions (0, 38, and 212 ms). Unless otherwise noted, a paired samples t test was conducted to test for the main priming effect across the baseline and 38 ms condition.

Stimuli

A set of 85 homograph targets was selected from the Nelson Norms. Approximately half of the homographs were balanced in terms of the association strength to two alternative meanings. For example, when given the target homograph pupil, participants are as likely to respond with the word eye as they are to student. The other half of the list consisted of homographs that were polarized in meaning. When presented with the target homograph bank, for example, participants are much more likely to respond with the money meaning rather than the river meaning in the absence of a prime. A within-subjects design was used in which the masked prime was related to either meaning of the target homograph. For the balanced homographs, half of the participants were primed with one meaning and the other half were primed with the other meaning. For the polarized homographs, all participants were primed with the subordinate meaning because it would be especially difficult for participants to follow exclusion instructions if the dominant meaning was flashed. Items were then counterbalanced across six lists according to meaning and word-duration pairing.

Procedure

Participants were tested with the same procedure as Experiment 1 except that they were instructed to respond with the "first word that comes to mind related to the meaning of the homograph" (e.g., pupil), but not related to the meaning of the prime (e.g., student) (e.g., respond with eye). If they didn't see the prime, they were instructed to respond with the first word that came to mind related to the meaning of the target homograph.

Participants

Fifty-one Montana State University undergraduates participated for credit in requirement of an introduction to psychology class. All participants had normal or corrected to normal vision and were native English speakers.

Results

A paired samples t test was conducted to test for the main effect of the briefly presented semantically related prime compared to the baseline (0 ms) condition. Item level analysis was also conducted on priming effects to see if perceptual and semantic characteristics of the stimuli predicted priming. These factors included LSA values, Nelson Norm values, and frequency of prime target pairs. These factors were tested by calculating r correlations between priming and the specific relevant factor.

Prime Identification

In the 212 ms condition, participants correctly reported the prime on 98% of the trials. In the 38 ms condition, participants reported the prime on 22% of the trials for balanced homographs and 16% of the time for the polarized homographs (when the subordinate meaning was flashed). A paired samples t test was conducted and

participants were able to report the prime in the balanced condition at a significantly higher percentage than in the condition when the subordinate prime was flashed, $t(50) = 3.147$, $p = .00$, $d = 1.0$. This effect could be due to the following: in the balanced condition the target served as a better cue and helped participants reconstruct a partially perceived prime, or the characteristics (frequency) related to the balanced primes allowed greater prime perceptibility. Frequency did not predict prime identification; however, backward prime-target association strength was a significant predictor, $r(118) = .273$, $p = .002$. This finding suggests that the balanced homographs did in fact serve as a better semantic cue than the polarized homographs in allowing participants to deduce the prime because the balanced homographs (pupil-student) are more strongly associatively related to the prime than the polarized homographs (bank-river).

Participants were more likely to report the prime in Experiment 2 compared to Experiment 1. Participants reported the prime in Experiment 1 reported the prime 16% of the time but in Experiment 2 reported the prime 23% of the time, $t(106) = 1.67$, $p = .09$, $d = .37$.

Overall Prime Identity Response

For the balanced homographs, participants responded with the identical flashed word 11% of the time in the baseline condition. This percentage dropped to 10% in the 38 ms condition; however, this 1% ± 3% difference was not significant, $t(50) = .700$, $p = .487$. When the subordinate meaning was flashed, participants responded with the

identical flashed word 8% of the time in the baseline condition and 5% of the time in the 38 ms condition. This 3% ± 3% drop was marginally significant, t (50) = 1.95], p. =.06.

Overall Associative Response

Participants responded with a word related to the meaning of the flashed word 44% of the time in the baseline condition for the balanced homographs. This percentage dropped to 40% in the 38 ms condition. This 4% ± 6% difference was not significant, t (50) = 1.245, p=.219. For the polarized homographs, participants responded with the word related to the meaning of the flashed word 17% of the time in the baseline condition and 14% of the time in the 38 ms condition. This 3% ± 4% drop was not significant, t (50) = 1.579, p=.121.

Prime Identity Response Upon Prime Report Failure

No significant identity priming was found for either the balanced or polarized homographs. Upon prime report failure, participants responded with the prime 10% of the time for the balanced homographs in the baseline condition. In the 38 ms condition participants responded with the flashed word 12% of the time. This 2% ± 4% increase was not significant, t (50) = -.818, p = .417. For the polarized homographs, participants responded with the prime 8% of the time in the balanced baseline condition. This percentage dropped to 6% for the 38 ms condition, t (50) = 1.442, p = .155. This 2% ± 3% difference was not significant.

Associative Response Upon Prime Report Failure

For the balanced homographs participants responded with a word related to the meaning of the prime 44% of the time in the baseline condition. This dropped by 1% ± 5% to 43% in the 38 ms condition. A paired samples t test reveals no significant unconscious semantic priming in the balanced homograph condition, $t(50) = .25$, $p = .81$, $d = .04$; however when a subordinate prime preceded a homograph target, participants displayed marginally significant inhibition priming. In the baseline condition, participants responded with a word related to the meaning of the flashed word 17% of the time. This percentage dropped by 4% ± 4% to 13% in the 38 ms condition suggesting that when the participants failed to report the prime in the 38 ms condition, they were less likely to respond with a word related to the meaning of the flashed word, $t(50) = 1.93$, $p = .06$, $d = .34$.

In the 212 ms condition participants demonstrated a failure to follow exclusion instructions 18.5% of the time. This ability to follow instructions was in part determined by the nature of the prime-target relationship. In the balanced homograph condition participants did not follow exclusion instructions on 27% of the trials even though these participants were able to report the prime. When the subordinate prime was flashed participants demonstrated exclusion failure on only 10% of the trials. This suggests that participants had a more difficult time switching between meanings for balanced homographs.

Data was aggregated by items, averaged across all participants, and correlations were conducted between priming and frequency, association strength (Nelson, LSA), fan-in, and fan-out values. None of the variables was found to predict differences in responses between the 38 ms and baseline condition when participants failed to report the prime. The items analysis for the balanced homographs in Experiment 2 also failed to replicate the significant priming found in the Experiment 1 items analysis, $t(83) = .381$, $p = .70$, $d = .07$. Observed power for Experiment 2 to detect the items priming ($d = .16$) found in Experiment 1 was calculated and found to be sufficient further suggesting that priming in Experiment 1 was artifactual.

Discussion

The relatively high percentage of trials that participants demonstrated exclusion failure in Experiment 2 warrants caution. The 27% exclusion failure rate for balanced homographs supports Block's (2001) suggestion that the exclusion task is difficult and measures of priming may reflect performance under difficult conditions. The issue is especially pertinent to Experiment 2. Prior studies of unconscious perception using an exclusion paradigm have used a stem completion task as the indirect measure of priming. Experiment 2 implemented a much more difficult task when the participant had to overcome the dominant response evoked by the prime-target homograph relationship and respond with a word related to a different meaning of the two words. The 17% drop in

exclusion failure rate that occurred when participants saw the subordinate prime for the polarized homographs suggests that it was much easier to respond with a word related to the dominant meaning of a homograph than its less common meaning (i.e. responding money when bank is the target and river is the prime).

The inhibition priming found for trials when the subordinate prime was flashed warrants further discussion. One possible explanation for this effect is Carr and Dagenbach's (1990) Center-Surround unconscious priming mechanism to explain these results. According to the theory, semantic information can be processed and represented unconsciously, but when the individual attempts to retrieve a specific representation, the suppression of related representations that compete for activation occurs. Usually this suppression is enough to bring the sought after information to awareness, but if the stimulus is sufficiently degraded, or the memory trace sufficiently weak, as in the case of a briefly flashed masked word, the mechanism of activation may not be enough to activate the sought after node. If retrieval is successful, the suppression of the surrounding nodes dissipates, but if retrieval failure occurs, this suppression remains. This process may account for the inhibition priming found in the subordinate homograph condition. Participants' attempt to activate the stored semantic representation of the unconscious prime may be suppressing related information thus causing inhibition priming. Center-Surround theory relies on participants' difficulty to perceive the primes for negative priming to occur (Carr & Dagenbach, 1990). Because the surrounding inhibition supposedly occurs when retrieval is unsuccessful, those trials that show the

most negative priming should also show declines in prime-report performance. That appears to be the case in the present study. When the subordinate prime is flashed, there is marginally significant negative priming and participants are also less likely to report these primes.

Center Surround relies on the assumption that information related to the meaning of the flashed prime is being represented in the unconscious a priori; however, other research suggests single process models of perception and semantic activation (Hutchison et al, 2004; Holender, 2004; Koudier & Doupioux, 2004). Furthermore, Center Surround claims that participants have an awareness of an unconscious representation of a word. Recently Kahan (2001) offered data that support an account of the center-surround mechanism that instead relies on participants' conscious residual awareness of the prime. Kahan suggests that expectancies may generate delayed responses when participants are focusing on the semantic relationship between prime-target pairs. In this account "inhibition" priming is actually due to the retrospective process of prime-target matching. Most evidence regarding the inhibitory mechanisms of center-surround theory and Kahan's subsequent counter argument rely on data collected using lexical decision tasks and naming latencies (Dagenbach & Carr, 2004), whereas the present study used accuracy data to measure priming. Kahan's (2001) analysis of Carr and Dagenbach's (1990) data focuses on a retrospective prime-target clarification process that delays participants' responses, thus producing negative priming for related words. In Experiment 2, participants were instructed to perform a free association task. If Kahan's interpretation of the data presented by Carr and Dagenbach is correct, we would not

expect negative priming when a task such as free association is used since this task is not quantified temporally but rather qualitatively (responding to the homograph target with a word related to either the same or different meaning of the prime).

The negative priming found in Experiment 2 was produced under different conditions than has been previously demonstrated (free association + exclusion task). Also, this effect was only marginally significant. This warrants further exploration. If negative priming truly occurs according to Carr and Dagenbach's prospective inhibition account, then I would expect an even stronger negative priming effect when participants are instructed to engage in an inclusion free association task (use the information presented in the prime) because participants would try even harder to bring the prime to awareness thus deactivating related nodes more strongly.

CHAPTER 6

EXPERIMENT 3

Experiment 3 sought to further explore the priming found in Experiments 1 and 2. The overall design and stimuli were identical to Experiment 2 except that participants were instructed to "respond with the first word that comes to mind that is related to the meaning of the flashed word". Experiment 3 was conducted for two reasons. The first was to explore the influence of task instructions on unconscious priming. If the semantic priming found in other studies is a result of methodological deficiencies (inability to rule out conscious effects), then I would expect unconscious semantic priming under inclusion instructions across all trials. This methodology closely mimics the paradigms that have been previously used to demonstrate unconscious semantic priming. If significant priming is found across all items but not found on the trials when participants failed to report the prime, then it would suggest that unconscious semantic priming is illusory and an experimental artifact. The second motivation for experiment 2 was to replicate the inhibition priming found in Experiment 2. According to Carr and Dagenbach's center-surround account of negative unconscious priming, it is expected that the inhibition priming found in Experiment 2, if genuine, will be even more pronounced when participants are performing an inclusion task.

Method

Design

Each homograph (pupil) was preceded by a masked prime (student or eye) that was related to either of the homograph's meanings. The primes were presented for 0, 38, or 212 ms. Identity priming and associative semantic priming results were reported from the 3 within-participants conditions (0, 38, and 212 ms). Unless otherwise noted, a paired samples t test was conducted to test for the main priming effect across the baseline and 38 ms condition.

Stimuli

A set of 85 homograph targets were selected from the Nelson Norms. Approximately half of the homographs were balanced in terms of the association strength to two alternative meanings. For example, when given the target homograph pupil, participants are as likely to respond with the word eye as they are student. The other half of the list consisted of homographs that were polarized in meaning. When presented with the target homograph bank, for example, participants are much more likely to respond with the money meaning rather than the river meaning in the absence of a prime. A within-subjects design was used in which the masked prime was related to either meaning of the target homograph. For the balanced homographs, half of the participants were primed with one meaning and the other half were primed with the other meaning. For the

polarized homographs, all participants were primed with the subordinate meaning because it would be especially difficult for participants to follow exclusion instructions if the dominant meaning was flashed. Items were then counterbalanced across six lists according to meaning and word-duration pairing.

Procedure

Participants were tested with the same procedure as Experiment 2 except that they were instructed to respond with the "first word that came to mind that is related to the meaning of the homograph (e.g., pupil), and is related to the meaning of the prime (e.g. student) (e.g. respond with eye). If they didn't see the prime, they were instructed to just respond with the first word that came to mind related to the meaning of the target homograph.

Participants

Sixty Montana State University undergraduates participated for credit in requirement of an introduction to psychology class. All participants had normal or corrected to normal vision and were native English speakers.

Results

Prime Identification

In the baseline (0 ms) condition participants were able to guess the prime 2% of the time for the balanced homographs and 1% of the time for the polarized targets. For the balanced homographs participants were able to identify the prime in the 212 ms condition 97% of the time, and for the polarized homographs participants were able to see the prime 95% of the time. In the 38 ms condition, participants were able to report the prime 28% of the time for the balanced homographs and 18% of the time for the polarized homographs. The effect of prime-target relation (balanced vs. polarized) found in experiment 2 was replicated in Experiment 3, $t(59) = 5.062$, suggesting that participants were significantly better able to perceive the prime on the balanced trials than in the polarized trials.

Overall Prime Identity Response

For the balanced homographs, participants responded with the identical flashed word 13% of the time in the baseline condition. This percentage dropped by 3% ± 3% to 10% in the 38 ms condition revealing only a marginally significant difference between the baseline and 38 ms condition, $t(59) = 1.84$, $p = .071$. For the polarized homographs (when the subordinate meaning was flashed), participants responded with the identical flashed word 4.5% of the time in the baseline condition. This decreased by .5% ± 2% to 4% in the 38 ms condition.

Overall Associative Response

Participants responded with a word related to the meaning of the flashed word 48% of the time in the baseline condition for the balanced homographs. This percentage increased by 13% ± 5% to 61% in the 38 ms condition. This 13% difference was significant, $t(59) = 5.46$, $p = .00$. For the polarized homographs, participants responded with the word related to the meaning of the flashed word 12% of the time in the baseline condition and 28% of the time in the 38 ms condition. This 16% ± 4% increase was significant, $t(59) = 6.56$, $p = .00$.

Prime Identity Response Upon Prime Report Failure

No significant identity priming was found for either the balanced or polarized homographs. Upon prime report failure, participants responded with the prime 13% of the time for the balanced homographs in the baseline condition. In the 38 ms condition participants responded with the flashed word 13% of the time. This difference was not significant, $t(59) = .09$, $p = .93$. For the polarized homographs, participants responded with the prime 5% of the time in the balanced condition. This percentage essentially remained the same in the 38 ms condition, $t(50) = .191$, $p = .849$, revealing no identity priming between baseline and 38 ms conditions on trials where participants failed to report the prime.

Associative Response Upon Prime Report Failure

A paired samples t test reveals no significant unconscious semantic priming in either the balanced or polarized homograph conditions upon prime report failure. In the baseline condition participants responded with a word related to the meaning of the flashed word 48% of the time for the balanced homographs and 12% of the time for the polarized homographs. These percentages remained unchanged for the balanced homographs 49% and increased by 3 ± 4% to 15% for the polarized homographs revealing no significant semantic priming upon prime report failure.

In the 212ms condition participants were unable to follow inclusion instructions 12% of the time overall. This ability to follow instructions was in part determined by the nature of the prime-target relationship. In the balanced homograph condition participants did not follow inclusion instructions 6% of the trials even though they were able to report the prime. When the subordinate prime was flashed participants demonstrated inclusion failure on 18% of the trials. This suggests that participants had a more difficult time following inclusion instructions when the subordinate prime was flashed.

Discussion

The most notable finding in Experiment 3 is the difference in priming between the overall associative response and associative response upon prime report failure. Under exclusion instructions (Experiment 2), participants showed no significant priming

regardless of whether all trials or just the trials where participants failed to report the prime were analyzed. Experiment 3 (under inclusion instructions), demonstrated strong "unconscious" priming under conditions that are similar to most studies that have claimed evidence of unconscious semantic activation (no prime report & participants using information presented in prime). This priming dissolved when only the trials where participants failed to report the prime were analyzed. These results are troubling for research methodologies that have been employed to demonstrate unconscious semantic priming (see Holender, 1986, 2004 for similar arguments). The present study demonstrates the importance of an adequate measure of conscious awareness when trying to show unconscious semantic priming and undermines claims that semantic processing occurs.

CHAPTER 7

GENERAL DISCUSSION

In summary, the results of Experiments 1-3 suggest that unconscious semantic priming is not a reliable phenomenon and is likely a product of methodological shortcomings. Significant "unconscious" semantic priming was demonstrated in Experiment 1 only when data was analyzed by items and averaged across participants. This priming was predicted by individual differences in ability to report the prime but not associated with semantic associative strength. The specific nature of these individual differences is an important question and the results of Experiments 1-3 are compelling. Although research has provided evidence for reliable unconscious perceptual or visual priming (Hutchison et al, 2004; Moshe & Biederman, 2004), the present data suggests a tenuous unconscious semantic word priming effect at best. It is likely that this effect is a result of response criterion artifacts (as suggested by Snodgrass, 2004, Hasse and Fisk, 2001). In fact, the negative relationship between participants' ability to detect the prime and priming in Experiment 1 suggests that differences in participants' response criterion could account for the appearance of priming. Macmillan (1986) proposed a similar explanation for unconscious priming. He claimed that unconscious priming could be the result of participants' subjective placing of their response criterion at a higher value than actual subjective awareness. As a result, participants could be aware of the prime at some level, but not be confident enough in the accuracy of this information to report the prime. In fact, Kunimoto (2001) reported that confidence predicts accuracy in

identification judgments. If participants are at least partially aware of the prime but fail to report this information, it is likely that this information will influence their performance on the indirect measure (stem completion). According to Block (2001), working under exclusion instructions is difficult, and exclusion failure (priming) could simply reflect participants' performance under conditions of uncertainty. Those participants that are more likely to report the prime (and thus more certain) are more likely to follow exclusion instructions. Because these participants' objective and subjective thresholds are more similar, they do not show priming. However, those participants who demonstrate a decreased ability to report the prime (more uncertain) are more likely to show priming. For these participants, the objective and subjective thresholds may be quite different. They may be able to perform at a much higher level than chance on an objective measure (discrimination) of awareness but have a much higher threshold for a subjective measure such as prime report. According to Lupker (1986), there is a continuum of increasing information between the objective and subjective thresholds. As this fuzzy area between actual awareness and response increases as a result of uncertainty (response bias), the participant has more conscious information available to use for the "indirect" measure (stem completion). Since they didn't report the prime, they operate under the assumption that they didn't have to follow exclusion instructions and simply report the first word that comes to mind as a possible completion. The first word that comes to mind is likely related to the participants' partial guess of the prime, and produces an exclusion failure and the consequent illusion of unconscious semantic priming. It is also important to note that in terms of cognitive

efficiency from the participants' perspective, it is much easier to disregard reporting the prime in the 38 ms condition if they were partially aware of it. If participants were able to guess the identity of the prime but did not report it, this information subsequently would help them in completing the stem completion task. In fact this is the most efficient means by which a participant can complete the stem. As a result, it is likely that on a substantial number of trials, some participants did not report the prime when they in fact saw it and that partially perceived primes contributed to supposed "unconscious" priming.

Experiment 2 generated only a marginal inhibition priming effect that did not replicate in Experiment 3 suggesting that semantic information was not processed unconsciously. It is important to note that there was also no significant identity priming found in Experiments 2 and 3. If subliminal priming is primarily a result of sub-word perceptual processing then we would not expect identity priming using a free association task. Identity priming has previously been demonstrated using a stem completion task which provides a portion of the prime as a cue for the participants' response. Sub-word perceptual characteristics of the prime can account for priming in this task. If priming is in fact a result of sub-word perceptual processing (as noted by Hutchison et al, 2004), then we would not expect identity priming when a conceptually driven task such as free association is used.

Experiment 2 failed to replicate the item priming found in Experiment 1. This would be expected if the priming in the stem completion task (Experiment 1) was a result of participant response bias. In a stem completion task, the stem mo--- provides little

information that would increase confidence in a participant's guess of the prime. This is evidenced by the lack of correlation in Experiment 1 between target stem completion characteristics (Nelson values, LSA) and prime identification. Conversely, the presentation of the full target word in the free association task (Experiment 2) provides a strong semantic cue related to the meaning of the prime. In fact, the strength of this semantic cue was found to significantly predict prime report in the free association task, $r(118) = .273$, $p = .002$. I would propose that the presentation of the associatively related target word boosts the participant's confidence in their guess of the prime, causing them to be more likely to report it. Participants were more likely to report the prime in Experiment 2 (23%) than in Experiment 1 (16%), $d = .37$. Thus, the presentation of the target in this way would effectively diminish the gray area between actual awareness and prime report that contributed so heavily to the priming found in Experiment 1.

Further Research

A way to rectify the response criterion problem in Experiment 1 is to set very liberal conscious identification criterion "report any information you've seen". The reason that such a liberal criterion was not set is because research has shown to eliminate even conscious semantic priming when participants are instructed to focus on the letter level rather than the word level (Manwell, L., Roberts, M. & Besner, D., 2004). It was assumed that under this task, the focus on letter/sub-word level information may have minimized this paradigm's sensitivity to semantic priming. I would predict that under a

more liberal prime report threshold, any supposed “unconscious” semantic priming would be eliminated.

The inhibition priming found in Experiment 2 is also interesting. The present work is not equipped to explore this effect. It would be interesting to repeat the study and explore possible moderating variables. Further research may also be needed to support the claim that the semantically related target in Experiment 2 increases prime report and confidence thus decreasing priming.

Conclusion

In 1986, Dixon claimed that reservations regarding unconscious semantic priming were akin to the doubts of people who believed the earth was flat when faced with new evidence. In the end, it seems the evidence is mounting against the validity of studies claiming unconscious semantic priming. The recent findings suggesting that unconscious semantic/identity priming is perceptual in nature (Hutchison et al, 2004, Abrams & Greenwald, 2000; Masson & Isaak, 1999), coupled with the present results, support the claims of Holender’s often cited (1986) vanguard critique of studies suggesting unconscious semantic processing. Perhaps, by Dixon’s analogy, the earth is flat after all.

REFERENCES

Abrams, R., & Greenwald, A. (2000). Parts outweigh the whole (word) in unconscious analysis of meaning. *Psychological Science*, 11, 118-124.

Abrams, R., Klinger, M., & Greenwald, A. (2002). Subliminal words activate semantic categories(not automated motor responses). *Psychonomic Bulletin and Review*, 9(1), 100-106.

Balota, D. (1983). Automatic semantic activation and episodic memory encoding. *Journal of Verbal Learning & Verbal Behavior*, 22, 88-104.

Balota, D., Cortese, M., Hutchison, K., Neely, J., Nelson, D., Simpson, G., Treiman, R. (2002). The English Lexicon Project: A web-based repository of descriptive and behavioral measures for 40,481 English words and nonwords. http://elexicon.wustl.edu/.

Balota, D., Cortese, M., Sergent-Marshall, S., Spieler, D., Yap, M. (2004). Visual word recognition of single-syllable words. *Journal of Experimental Psychology: General*, 133, 283-316.

Besner, D. & Smith, M. (1992). Models of visual word recognition: When obscuring the stimulus yields a clearer view. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, 18, 468-482.

Block, N. (2001). Paradox and cross purposes in recent work on consciousness. *Cognition*, 79, 197-219.

Broadbent D.E. (1958). Perception and communication. Oxford: Oxford University Press.

Carr, T., & Dagenbach, D. (1990). Semantic priming and repetition priming from masked words: Evidence for a center surround attentional mechanism in perceptual recognition. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, 16, 341-350.

Collins, A. & Loftus, E. (1975). A spreading activation theory of semantic processing. *Psychological Review*, 82, 407-428.

Coltheart, M. (1981). The MRC Psycholinguistic Database, *Quarterly Journal of Experimental Psychology*, 33A, 497-505.

Debner, J. & Jacoby, L. (1994). Unconscious perception: Attention, awareness, and control. *Journal of Experimental Psychology: Learning Memory, & Cognition* 20, 304-317.

Deutsch, J., & Deutsch, D. (1963). Attention: Some theoretical considerations. *Psychological Review*, 70:80-90.

Dixon, N. F. (1986). On private events and brain events. *Behavioral and Brain Sciences*, 9, 29-30.

Erdelyi, M., (2004). Subliminal perception and its cognates: Theory, indeterminacy, and time. *Consciousness & Cognition: An International Journal*, 13.

Forster, K., Booker, J., Schacter, D., Davis, C. (1990). Masked repetition priming: Lexical activation or novel memory trace? *Bulletin of the Pychonomic Society*, 28,341-345.

Forster, K. (1998). The pros and cons of masked priming. *Journal of Psycholinguistic Research Special Issue: Celebrating a quarter century of Psycholinguistic research*, 27, 203-233.

Fowler, C., Wolford, G., Slade, R., & Tassinary, L. (1981). Lexical access without awareness. *Journal of Experimental Psychology: General*, 110, 341-362.

Haase, S., & Fisk, G. (2004). Valid distinctions between conscious and unconscious perception? *Perception & Psychophysics*, 66, 868-871.

Haase, S., Theios, J., & Jenison, R. (1999). A signal detection theory analysis of an unconscious priming effect. *Perception & Psychophysics*. 61, 986-992.

Holender, D. (1986). Semantic activation without conscious identification in dichotic listening, parafoveal vision, and visual masking: A survey and appraisal. *Behavioral & Brain Sciences*, 9, 1-66.

Hutchison, K., Neely, J., Neill, T., & Walker, P. (2004). Is unconscious identity priming lexical or sub-lexical? *Consciousness & Cognition: An International Journal*, 13, 512-538.

Jacoby, L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language*, 30, 513-541.

Key, W. (1973). Subliminal Seduction. New York: Signet.

Kunimoto, C., Miller, J., & Pashler, H. (2001). Confidence and accuracy of near threshold discrimination responses. *Consciousness & Cognition: An International Journal*, 10, 294-340.

Landauer, T.K., Foltz, P.W., & Laham, D. (1998). Introduction to Latent Semantic Analysis. *Discourse Processes*, 25, 259-284.

Manwell, L., Roberts, M. & Besner, D. (2004). Single letter coloring and spatial cuing eliminates a semantic priming contribution to the Stroop effect. *Psychonomic Bulletin and Review*, 11, 458-462.

Marcel (1983). Conscious and unconscious perception: Experiment on visual masking and word recognition. *Cognitive Psychology*, 15, 197-237.

Masson, M., & Isaak, M. (1999). Masked priming of words and nonwords in a naming task: Further evidence for a nonlexical basis for priming. *Memory & Cognition*, 399-412.

McClelland, J.L., (1989). Parallel distributed processing: Implication for cognition and development. In Morris, R. (Ed)., Parallel distributed processing: Implications for psychology and neurobiology. (pp 8-45) New York: Oxford University Press.

Merikle, P. (1982). Unconscious perception revisited. *Perception & Psychophysics*. 31, 98-301.

Merikle, P, & Daneman, M. (1998). Psychological Investigations of Unconscious Perception. *Journal of Consciousness Studies* 5, 5-18.

Merikle, P., & Reingold, E. (1998). On demonstrating unconscious perception: Comment on Draine and Greenwald. *Journal of Experimental Psychology: General*, 127, 304-310.

Merikle, P., & Reingold, E. (1990). Recognition and lexical decision without detection: Unconscious perception? *Journal of Experimental Psychology: Human Perception & Performance*, 16, 574-583.

Merikle, P., Smilek, D. & Eastwood, J. (2001). Perception without awareness: Perspectives from cognitive psychology. In Dehean, Stanislas Ed. The cognitive neuroscience of consciousness; 115-134. Cambridge MA. US 2001.

Moshe, B. & Biederman, I. (1998). Subliminal visual priming. Psychological Science, 9, 464-469.

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (1998). The University of South Florida word association, rhyme, and word fragment norms. http://www.usf.edu/FreeAssociation/.

Nolan, K., & Caramazza, A. (1982). Unconscious perception of meaning: A failure to replicate. *Bulletin of the Psychonomic Society*, 20, 23-26.

Norman, D., & Shallice, T., (1980): Attention to action: Willed and automatic control of behavior. CHIP Report #99. University of California, San Diego.

Ortells, J., Daza, M., & Fox, E. (2003). Semantic activation in the absence of perceptual awareness. *Perception & Psychophysics*, 65,1307-1317.

Rogers, Stuart (1993). How a publicity blitz created the myth of subliminal advertising. Public Relations Quarterly.

Ruz, M., Madrid, E., Lupianez, J., & Tudela, P. (2003). High density ERP indices of conscious and unconscious semantic priming. *Cognitive Brain Research*, 17, 719-731.

Schneider, W., Eschman, A., & Zuccolotto, A. (2001). E-Prime Reference Guide. Pittsburgh: Psychology Software Tools, Inc.

Sidis, B. (1898). The psychology of suggestion. New York: Appelton.

Snodgrass, M., Bernat, E., & Shevrin, H. (2004). Unconscious perception: A model based approach to method and evidence. *Perception & Psychophysics*, 66, 846-867.

Treisman, A., (1964). Selective attention in man. British Medical Bulletin, 20, 12-16.