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Preferences and inferences in encoding visual objects: A systematic comparison of semantic and affective priming

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Abstract

The authors systematically compared semantic and affective priming in five studies involving words and pictures. In Studies 1 (lexical decision task) and 2 (evaluation task), irrelevant short duration (200 ms) primes were briefly flashed before relevant targets. We orthogonally varied both the semantic and affective relations between primes and targets. In both studies, we found semantic priming, but no affective priming. Study 3 revealed that the same stimuli can produce affective priming, but only when words come from a singular semantic category. Studies 4 and 5 used pictures rather than words to examine automatic encoding tendencies. The results conceptually replicated those from Studies 1 and 2. In sum, the findings suggest that affective priming may be a relatively fragile phenomenon, particularly when the semantic properties of objects vary in a salient manner.

Preferences and inferences in encoding visual objects: A systematic comparison of semantic and affective priming

Paramecia will approach favorable stimuli and avoid unfavorable stimuli (Schneirla, 1959). The fact that paramecia are capable of making this distinction suggests that evaluations may require relatively minimal processing. Similarly, in humans, research on "automatic affect" assumes the existence of a "quick-and-dirty" affective route for evaluation, a route that is not modified by goals or prior experiences (Bargh, 1997). However, recent reviews have suggested that the automaticity of evaluation is far more context-dependent than some have assumed (see Klauer & Musch, 2001, for a review). It is also true that, in the pursuit of "automatic affect," investigators have often ignored the fact that a variety of non-affective (i.e., cognitive) processes, such as identification and categorization, are also automatic in many respects (Mandler & Shebo, 1983; Neely, 1991).

A comparison of semantic and affective priming will have several theoretical benefits. First, to the extent that affective and semantic priming occur under different task conditions (Klauer & Musch, 2002) or follow different time courses (Klauer, Rossnagel, & Musch, 1997), one can potentially learn important differences between semantic processes on the one hand and affective processes on the other. Second, it is of interest to determine whether semantic or affective priming has the more robust tendency. Although the answer to this question may well depend on task conditions, it also seems possible that participants tend to favor one or the other as an initial basis for encoding objects. Third, in the absence of a comparative approach, any conclusions about the nature of the priming (i.e., as exclusively semantic or as exclusively affective) are potentially problematic. For example, affective priming might, under certain circumstances, be semantic priming in disguise, particularly to the extent that negative objects share certain features (e.g., slimy, dark in color) that tend to differentiate them from positive objects (e.g., soft, fuzzy in texture). Such a possibility is at least consistent with feature-based views of semantic priming (e.g., McRae & Boisvert, 1998). To the extent that one form of priming is found without the other, such ambiguities are ruled out with a comparative priming analysis.

The affective priming effect has a relatively shorter history than the semantic priming effect. The affective priming effect may also be more controversial at the present time, particularly in terms of moderating conditions and mechanisms (e.g., Fazio, 2001). For these reasons, we review recent research on affective priming before introducing our comparative approach.

Affective Priming

Recent support for the automaticity of evaluation comes from the affective priming paradigm (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). Typical results indicate that target words are judged (or pronounced) faster if preceded by a short-duration (typically 300 ms) prime of similar valence (Bargh, Chaiken, Govender, and Pratto 1992; Bargh, Chaiken, Raymond, & Hymes, 1996; Fazio et al., 1986). For example, the prime word "grumpy" will facilitate an evaluative response to the target word "disgust", relative to the target word "sunshine" (see Klauer, 1998, for a review). When the prime-target combinations are congruent (i.e., good-good or bad-bad, relative to good-bad or bad-good), responses are faster, suggesting that people are automatically encoding the valence of the prime. Bargh (1997) claimed that affective priming was a

result of an unconscious automatic processor that makes crude good/bad distinctions regardless of one's current processing goals.

The idea of attitudes being activated automatically began with a study by Fazio et al. (1986). In their study, participants first rated objects as good or bad. Strong attitudes were operationally defined as quicker evaluation judgments. These objects were then used as primes in an evaluation task with positive and negative adjectives as targets. The stimulus-onset a synchronicity (i.e., prime onset to target onset latency) was 300 ms, as in many subsequent studies. Fazio et al. (1986) found significant affective priming for objects associated with strong attitudes, but not for objects associated with weak attitudes. Subsequent studies by Bargh et al. (1992) suggested that the automaticity of evaluation is equally true for objects associated with weak (as well as strong) attitudes. A debate concerning the scope of the activation effect, as well as the mechanisms involved, produced some convincing data for both positions (Chaiken & Bargh, 1993; Fazio, 1993). The resolution of this debate is unclear at this point (Fazio, 2001).

Putting the issue of mechanism aside for the moment, affective priming has now been shown in a number of studies. Bargh et al., (1992) found affective priming using good and bad adjectives as stimuli. However, their participants were asked to evaluate target words, rendering it possible that affective priming depended on having a conscious goal to evaluate (Klinger, Burton, & Pitts, 2000). To remove this source of ambiguity concerning the unconditional nature of affective priming, Bargh et al., (1996) conducted further studies using a pronunciation task. Because affective priming emerged even under these conditions, the authors concluded that affective priming is robust and unconditional (i.e., task-independent). More recently, Giner-Sorolla, Garcia, and Bargh (1999) demonstrated affective priming using good and bad pictures as primes. Other researchers have also found affective priming with words (Hermans, De Houwer, & Eelen, 1994; Klauer, Roβnagel, & Musch, 1997), pictures (De Houwer & Hermans, 1994), and a pronunciation task (Hermans et al., 1994), providing further support for the robust nature of affective priming.

Affective priming has also been found with several other paradigms including a subliminal evaluation task with masked primes (Klinger, et al., 2000), an affective Simon task (De Houwer & Eelen, 1998), an affective Stroop task (Pratto & John, 1991; Pratto, 1994; Wentura, Ruthermund, & Bak, 2000), and tasks with concurrent cognitive load (Hermans, Van de Broeck, & Eelen, 1998; Hermans, Crombez, & Eelen, 2000). In short, the affective priming phenomenon has been found using a variety of different stimulus materials and experimental paradigms (see Klauer & Musch, in press, for a review).

Affective Priming: Spreading Activation, Response Competition, or Affective Matching?

A number of studies have produced affective priming, but the underlying mechanism, if there is a primary one, is unclear at this point. Here we will review evidence for several prominent accounts of affective priming; however, our review is not meant to be exhaustive. Three promising accounts of affective priming propose three non-overlapping mechanisms, one specific to a spreading activation mechanism (Bargh, 1997), one specific to response competition processes (Klauer, 1998; Klinger et al., 2000), and one specific to an affective matching mechanism (Klauer & Musch, 2002; Wentura, 2000).

A spreading activation account of affective priming was proposed by Bargh (1997). He proposed that, regardless of attitude strength or the task in question, primes

are automatically evaluated. Furthermore, the valence of the prime activates a general purpose evaluation node, either one specific to positive objects (if the prime is positive) or one specific to negative objects (if the prime is negative). The activation of one of these nodes, in turn, speeds the retrieval of a like-valenced object. For example, "skunk" primes a negative evaluation, which in turn primes "grumpy". Note that the prime and target share relatively little in a semantic sense (e.g., one is an animal whereas the other is a trait term); however, they do share a normative evaluation (i.e., negative).

Several results suggest that a spreading activation account of affective priming is likely to encounter difficulties, at least as an exclusive explanation for the affective priming phenomenon. In particular, there is general agreement that affective priming is more robust in the evaluation task than in tasks (such as lexical decision or pronunciation) that do not depend on evaluating targets (De Houwer et al., 1998; Hermans, De Houwer, & Eelen, 2001; Klauer, 1998; Klauer & Musch, 2001). For example, in attempting to replicate the results of Bargh et al. (1996), Klauer and Musch (2001) conducted five attempts to obtain affective priming within the pronunciation task. All of them failed despite adequate power and careful attention to the details of the Bargh et al. (1996) procedures. Klauer and Musch (2001) concluded that affective priming within the pronunciation task does not appear to be robust. These data, although they do not rule out the type of spreading activation mechanism proposed by Bargh (1997), are at least problematic with reference to it.

To the extent that affective priming is more robust in the evaluation task than in other tasks (e.g., Klauer, 1998), it seems likely that a response competition mechanism may be operative. Stated generally, response competition occurs when both an irrelevant stimulus and a relevant stimulus activate co-occurring response tendencies (see Kornblum, Hasbroucq, & Osman, 1990, for a review). In the context of affective priming and the evaluation task, a "good" prime (e.g., sunshine) would activate a good response, whereas a "bad" prime (e.g., headache) would activate a bad response. If the target requires a response that is congruent in valence with the prime (i.e., good-good or bad-bad), the response would be faster; if the target requires a response that is incongruent in valence with the prime (i.e., good-bad or bad-good), the response would be slower. The important point here is that response compatibility effects are quite common when the task is designed so that irrelevant stimuli would be associated with a correct response (i.e., good or bad) if relevant (Kornblum et al., 1990). Stated this way, affective priming would not be uniquely affective in nature, but rather would be a specific case of a more general response compatibility principle (De Houwer, 2001; Klauer & Musch, in press).

Response competition effects should arise only when the task at hand introduces the possibility of response competition. Spreading activation effects, by contrast, should occur regardless of the task at hand. Armed with this reasoning, Klinger et al. (2000) sought to determine whether response competition was a viable explanation for affective priming. Consistent with this idea, affective priming occurred only when participants were asked to evaluate targets; by contrast, it did not emerge when participants made semantic (e.g., animate vs. not) decisions. Also consistent with a response compatibility principle, semantic priming emerged only when participants made semantic decisions. Thus, the Klinger et al. (2000) results suggest that there is nothing particularly unique about affective, as opposed to semantic, priming. This said, it is noteworthy that Klinger et al.'s procedures involved subliminal priming in combination with a response deadline

procedure. Klinger et al. (2000) speculated that such procedures may preclude spreading activation processes. However, other authors have similarly suggested that response competition, rather than spreading activation, plays a major role in affective priming (De Houwer, 2001; Franks, Roskos-Ewoldsen, Bilbrey, & Roskos-Ewoldsen, 1998; Klauer, 1998; Rothermund & Wentura, 1998; Wentura, 2000).

A response competition mechanism, however, cannot explain the results of several studies suggesting that affective priming occurs in the lexical decision (e.g., Wentura, 2000) and pronunciation (e.g., Bargh et al., 1996) tasks. Do such data argue for a spreading activation explanation of affective priming? Not necessarily, as several authors have recently proposed yet a third mechanism to account for affective priming, at least in certain contexts. According to this affective matching account, participants have a tendency to consider the affective congruence of primes and targets as a pair. Affectively congruent pairs elicit a tendency towards an affirmative (i.e., yes) response, whereas affectively incongruent pairs elicit a tendency towards a rejection-related (i.e., no) response. Because the lexical decision task requires yes responses for words, the matching mechanism results in faster latencies for affectively congruent pairs relative to affectively incongruent pairs (Klauer & Musch, 2002; Wentura, 2000; Wentura & Rothermund, in press). Wentura (2000) provided further evidence for this mechanism by showing that affectively incongruent trials were faster when a rejection-related response was required for words. The procedural details of this study are intriguing, but complicated. Suffice it to say that there is evidence for this third account of affective priming, at least within certain judgment contexts (see also Klauer & Musch, 2002).

In summary, at least three mechanisms for affective priming receive some support within the literature. However, the checkered nature of support for each mechanism renders overall conclusions difficult. A response competition account of affective priming appears to be very promising, but cannot explain the cases in which affective priming occurs in non-evaluative tasks. A spreading activation account, by contrast, can explain affective priming within non-evaluative tasks, but not the fact that affective priming is more robust in the evaluation task. Finally, an affective matching account can explain affective priming within the lexical decision task, but not affective priming within pronunciation or evaluation tasks.

These considerations invite the speculation that affective priming may be a more context dependent (and possibly weaker) phenomenon than semantic priming. In this connection, spreading activation is the one mechanism that should facilitate congruent prime-target pairs regardless of the task at hand. And we know that there is robust evidence that such a mechanism is involved in semantic priming (McRae & Boisvert, 1998; Neely, 1991). By contrast, the evidence favoring such a mechanism in affective priming is weaker (Klauer, 1998; Klauer & Musch, in press). Response competition is a mechanism also common to both forms of priming (Klauer & Musch, 2002; Klinger et al., 2000). Of note, response competition tends to occur only under certain task conditions; as such, the mechanism has a more limited scope than a spreading activation one. The affective matching mechanism is perhaps unique to affective priming (Klauer & Musch, 2002; Wentura, 2000). However, its scope is limited and comparable post-lexical mechanisms have also been proposed to account for semantic priming (see Neely, 1991, for a review). On balance, then, semantic priming may typically be a more robust

tendency than affective priming, particularly under task conditions that minimize response competition and post-lexical strategies.

Encoding Visual Objects: A Comparative Analysis

Given that objects vary in both semantic and affective aspects, it is of interest to determine if one type of analysis – either semantic or affective – is the preferential basis for encoding. There are several possibilities here. Objects may be first classified according to a crude good/bad distinction before semantic analysis occurs (Bargh, 1997). This possibility would tend to favor affective priming as the more robust phenomenon. By contrast, objects may first be classified according to semantic categories before affective analysis occurs (Rolls, 1999; Storbeck, Robinson, & McCourt, 2002). This possibility would tend to favor semantic priming as the more robust phenomenon. Other possibilities are also evident. If semantic and affective analysis occurs in parallel (Zajonc, 1980), semantic and affective priming may typically be additive phenomena. Finally, semantic and affective priming may interact such that the largest amount of priming is observed when primes and targets match in both category membership (e.g., both animals) and affective valence (e.g., both negative). Such a possibility would be consistent with the idea that objects are jointly clustered in semantic memory according to both category membership and valence. A systematic comparison of semantic and affective priming, then, would seem to be valuable for determining how objects are encoded and represented in memory.

There have been relatively few studies that have systematically compared the role of semantic and affective factors in encoding visual objects. However, in the few studies that have sought such a comparison, semantic features seem to be classified faster than affective features. In a simple study, Mandler and Shebo (1983) presented the same evaluative words within lexical decision and evaluation tasks. They found that lexical decisions were faster, suggesting that objects are categorized, at least with regard to lexical status, before they are evaluated. In a second study with paintings as objects, Mandler and Shebo (1983) found that memory decisions (i.e., whether a painting was old or new) were faster than evaluative decisions (i.e., whether a painting was liked or disliked). Perhaps there are limits to these data in the present context. However, Schmidt-Atzert (1988) reported similar results. Furthermore, his analysis of ERP data coincided with his analysis of RT data: The brain appears to categorize objects before it evaluates them (see also Rolls, 1998; Storbeck et al., 2002).

Additionally, neurocognitive studies (using EEG and MEG along with other brain-imaging techniques) have provided evidence that a variety of cognitive processes, specifically related to old/new recognition, identification, and categorization, occur prior to any differential amygdala activation (Halgren et al., 2000; Seeck et al., 1997; Van Rullen & Thorpe, 2001). This suggests that the visual system performs a variety of cognitive tasks before a stimulus can be evaluated. In one particularly intriguing study, Fukudo, Ono, and Nakamura (1987) more directly examined the dependence of affective analysis on prior cognitive processing. In this study, the investigators temporarily de-activated the higher visual areas (e.g., the inferior temporal visual cortex), meanwhile leaving the amygdala intact. Consistent with the idea that affective analysis depends on prior cognitive processing, both behavioral data and single cell recording within the amygdala revealed a marked inability to respond appropriately to valenced objects.

Relatedly, LeDoux (1996) has identified a more rudimentary route (low route) that can be used for crude good/bad judgments. Affective primacy theorists (Bargh, 1997; Zajonc, 2000) have used this pathway to argue that stimuli are evaluated, at least at a crude level, in terms of affect before cortical (e.g., cognitive) analysis. However, a recent review (soon to be) by Storbeck (in prep) has argued that the low route is not a viable pathway for 'simple' social stimuli, including Chinese ideograms. To be more specific, a study by Davis et al., (2002) has found that when the rat brain is fully intact during a startle-blink conditioning task (light CS+), the low route pathway is not used. Furthermore, other studies have demonstrated that simple discrimination between a high pitched tone (CS+) and a low pitched tone (CS-) in a paired shock conditioning experiment with rats have resulted in tone indiscriminant conditioning when the auditory cortex is removed. Storbeck (in prep) therefore, concludes that the low route is not a viable route for affective analysis, even at a 'crude' level and cortical analysis is needed to determine the stimulus' identity for appropriate affective labeling.

In summary, our analysis tends to suggest that semantic priming should be more robust than affective priming. This would be true if people tend to make semantic distinctions before determining an object's valence.

The Present Studies

The current study takes advantage of a comparative priming paradigm. As suggested earlier, the comparative priming paradigm is necessary to directly compare affective and semantic priming. To do this, the stimuli have been selected to orthogonally posses both a valence and category specific relation. Therefore, the prime and target can have simultaneously independent relations relative to affective and category relationships. For example, a prime "puppy" and a target "smooth" share an affective relationship (e.g., good), but lack a category relationship (e.g., animal vs. texture). In sum, the prime and target relation varies in both an affective and category dimension, which will allow us to determine the encoding tendencies of participant's and whether it biases affect, category, or both simultaneously.

In the five studies that follow, we systematically manipulate both the semantic and affective congruence of prime-target pairings. Studies 1, 2, and 3 use word stimuli as primes, whereas studies 4 and 5 use picture stimuli. Studies 1 and 4 use a lexical decision task, Study 5 uses a semantic categorization task, and studies 1, 3, 4, and 5 use an evaluation task. Studies 1, 2, 3, and 5 used a 300 ms delay between prime and target, whereas Study 4 used a simultaneous presentation. In sum, the studies were diverse enough to establish the generality of our results.

To anticipate our conclusions, it appears that semantic priming is more robust than affective priming. Stated another way, it appears that people must know what something is before they know how they feel about it (Clore & Ketelaar, 1997; Clore & Ortony, 2000; Lazarus, 1991; Mandler & Shebo, 1983).

Study 1

In the semantic priming literature, the lexical decision task (LDT) has been useful in studying spreading activation (Balota & Lorch, 1986; Neely, 1991). Typically, the LDT requires a participant to ignore a prime word and determine whether a target is a word or not. With the lack of a specific task demand (e.g., to evaluate or categorize the target), the LDT does not favor either semantic or affective priming from a response

competition perspective (De Houwer, 2001). However, it has been suggested to be a 'pure' automatic spreading of activation measure for semantic associations (Balota & Lorch, 1986; Neely, 1991). In sum, the LDT will favor the accessible relationship that is best expressed with the spreading of activation account.

Method

Participants

Participants in the experiment were 46 psychology undergraduates from the University of Illinois who received credit for their class.

Apparatus and Stimuli

PC computers and monitors were used to run the study. Participants sat approximately 36-48 cm from the screen.

Prime stimuli were all words selected at random, without replacement, from a 2 (category: religion vs. animal) x 2 (affect: good vs. bad) design. Word targets were also selected at random without replacement from the same list and from an additional list of non-word letter strings. Thus, primes and targets could either be congruent (animal-animal or religion-religion) or incongruent (animal-religion or religion-animal) in semantic relation. Orthogonal to this category congruence variable, primes and targets could either be congruent (good-good or bad-bad) or incongruent (good-bad or bad-good) in affective connotation. There were 20 religious words and 20 animal words. Within each category, half of the words were positive and half were negative. See Appendix A for a list of the word stimuli. Each target word was repeated twice. Thus, there were 80 trials that required a "word" response. Forty non-word targets were also repeated twice, for a total of 80 "non-word" trials.

Procedure

The participants sat in front of the computer screen and were presented instructions on the monitor. The participants were instructed to ignore the first (prime) word and to indicate whether the second letter-string (target) represented a word or non-word by pressing the 9-key or the 1-key, respectively. After the participants finished reading the instructions, the experimenter made sure that they were clearly understood, and the participants pressed a key to begin the task. Primes were presented for 200 ms followed by a 100 ms blank screen, then the targets (Neely, 1991). Targets remained on the screen until a response was registered. Incorrect responses were punished by a computer-generated tone.

Results

Word Ratings. The words used in studies 1, 2, & 3 were rated by 20 participants from the University of Virginia and received class credit for their participation. The participants rated the words on a 7 point scale with (1) relating to 'not at all' and (7) 'very much so' along a "good" and "bad" dimension. The "bad" ratings were reversed scored so a score of 1 means the object is very bad and a score of 7 means the object is not bad at all. The mean ratings for each word were then computed within each category. Thus, the animal words had a "good" and a "bad" mean, the texture and religion words also had separate "good" and "bad" means.

Animals words rated as good had a mean of 5.86, while the bad words had a reverse mean of 2.32. With a One-Way ANOVA, the good animals word rated more good, relative to the bad words as being rated more bad, $F(1,19) = 158.19$, $p < .0001$. Religion words rated as good had a mean of 6.00 and bad words were reversed scored to

have a mean of 1.79. The One Way analysis demonstrated this difference to be significant, $F(1,19) = 178.08$, $p < .0001$. Finally, the good texture words had a mean of 5.83, while the bad texture words were reversed scored and rated 2.64. Again the One-Way ANOVA produced a significant difference between the affective relation, $F(1,19) = 160.47$, $p < .0001$. In sum, the good words were rated as good, while the bad words were rated as bad.

Reaction Time Analysis

The first five trials were treated as practice and removed from the analysis. Trials involving non-word targets or incorrect responses were also removed (see below for analysis of error rates). In addition, latencies that were 2 standard deviations below (315 ms) or above (1,301 ms) the overall group mean were replaced with these values (4% of the trials).

Our hypothesis is that we should observe categorical priming, but not affective priming. To assess predictions derived from this hypothesis, we computed four latency means for each participant. Specifically, trials were classified as congruent or incongruent in category membership as well as congruent or incongruent in affective connotation. Thus, categorical congruence (congruent vs. incongruent) and affective congruence (congruent vs. incongruent) were both within-subject repeated measures. As predicted, a 2 (category congruence) x 2 (affective congruence) ANOVA revealed a main effect for category congruence on mean latencies, $F(1,45) = 4.60$, $p < .05$. By contrast, there was no main effect for affective relation, $F < 1$, and the interaction was also not significant, $F(1,45) = 1.64$, $p > .20$. Thus, the results support semantic spreading of activation, but not affective spreading of activation. The relevant means are graphically displayed in Figure 2.

A second 2 x 2 ANOVA (same as above) was performed on accuracy rates. Interestingly, rather than revealing a speed-accuracy tradeoff, the results yielded complementary evidence for semantic priming. Specifically, participants were more accurate in classifying targets as words if primes and targets were congruent in category relation, $F(1,45) = 7.27$, $p < .05$. By contrast, there was no main effect for affective congruence, nor was there an interaction, $F < 1$.

Discussion

Study 1, which lacked relevant task demands, produced only semantic priming via spreading of activation. The lack of affective priming demonstrates that spreading of activation does not lead to affective priming, which is consistent with previous findings (Klauer et al., 1997; Klauer & Musch, 2001; Klinger et al. 2000). Since, no task demand to evaluate or categorize the targets was present, the results cannot be explained by a response competition mechanism. In sum, it appears the normative tendency is for spreading of activation to occur along the category, rather than affective, dimension.

Study 2

Study 2 was designed to extend the findings of Study 1 and to determine whether a task demand to evaluate can override the normative tendency to categorize stimuli. Previous studies have demonstrated stronger affective priming effects with an evaluation task, relative to non-evaluative tasks (Klauer, 1998). A comparative approach coupled with an evaluation task will help to delineate the natural tendency to categorize stimuli even with an apparent affective relationship present. Therefore, if category relations are accessed via spreading of activation, then participants will not encode the valence of the

prime, but rather the category relation. This would then inhibit a response competition tendency when evaluating the target, because the prime will not activate an affective response, but rather activate category information.

In Study 2, therefore, we employed the same type of 2 (category congruence) X 2 (affective congruence) design as in Study 1, within the context of an evaluation task.

Method

Participants

Participants were 43 undergraduate students from the University of Illinois who were paid $7.00 for their participation.

Apparatus and Stimuli

Between two and four students participated at a time. The experiment was conducted in a room with several cubicles, each cubicle containing a PC and a monitor. The participants sat 36 to 48 cm away from the computer screen with the keyboard comfortably in front of them.

The stimuli were two word lists created by the experimenters. The first list consisted of 20 animals. Ten of the words were negative in affective connotation (e.g. snake, spider) and the other 10 words were positive (e.g. puppy, rabbit). The second list consisted of 20 texture words, 10 of which were positive in valence (e.g. silky, velvet) and 10 of which were negative (e.g. coarse, rough). See Appendix B for a list of stimuli.

Procedure

The participants were provided with directions on the computer. The participant's task was to evaluate each target word by hitting the 1 key (bad) or the 9 key (good). They were told that they might see a word flashed before each target word, but that they should ignore this brief flash and evaluate the following word. Prime words were shown for 200 ms followed by a 100 ms blank screen, and then target words (Bargh et al., 1992). The target remained on the screen until the participant gave their evaluation. Incorrect responses were punished with visual error feedback.

The prime and target words were selected at random from the 2 (animals vs. textures) x 2 (good vs. bad) design. Thus, half of the trials were congruent in affect, whereas the other half were incongruent. Similarly, half of the trials were congruent in category membership, whereas the other half were incongruent. Each word was shown twice as a prime and twice as a target, resulting in 80 trials.

Results

As in Experiment 1 & 2, the first five trials were considered practice and trials with an incorrect response were discarded (approximate 5%). As in Study 1, latencies of 2 standard deviations below (340 ms) or above (1730 ms) the overall mean were replaced with these cutoff values (4% of the trials).

As in Study, mean latencies were examined as a function of a 2 (category relation) x 2 (affective relation) ANOVA. This analysis yielded a main effect for category congruence, F (1, 42) = 14.05, $p < .01$, no main effect for affective congruence, $F < 1$, and no interaction, F (1,42) = 3.31, $p > .05$. Thus, when category membership (of the prime and target) was congruent, target evaluations were facilitated. However, no facilitation occurred when the prime and target were congruent in affect. See Figure 2 for mean latencies.

Unlike in Study 1, accuracy rates were not affected by semantic congruence, F (1,42) = 1.63, $p > .20$, affective congruency, $F < 1$, or the interaction between these two variables, $F < 1$.

Discussion

In prior work on affective priming, researchers have seldom compared affective and semantic priming in a systematic manner. In the absence of such a design, it is impossible to say whether the stronger tendency is to encode primes according to their semantic features, their affect, both independently, or both interactively. By orthogonally varying both semantic and affective relations in the present study, we are able to comment on these alternative possibilities. The results of Study 2, like the results of Study 1, are surprisingly unambiguous. In both studies, the category congruence manipulation was significant, indicating that people's natural tendency is to categorize the primes (e.g., as animals vs. textures). In both studies, no affective priming was found.

Whereas the Study 1 task (lexical decision) did not favor either type of priming, the Study 2 task (evaluation) favored affective priming. In this connection, an evaluation task not only increases the salience of affective variations, but also introduces a response competition factor favoring affective priming (De Houwer, 2001). Despite the fact that the scales were tipped in favor of affective priming, semantic priming still proved to be the stronger phenomenon.

Study 3

Previous studies have typically found affective priming (Bargh et al., 1992) even in the context of a comparative priming task (Klinger et al., 2000). Therefore, one could argue that our stimuli lacks a salient affective relation, even though our stimuli were clearly were rated as good or bad by the participants. Therefore, we still thought it important to demonstrate that affective priming can occur with our stimulus lists. To do so, we removed the dual category dimensions (e.g., animal vs. texture) and had participants exposed to only a singular category dimension during each priming session. Therefore, spreading of activation should not occur along a category dimension and the prime should access the affective relation leading to affective priming via response competition mechanism.

Method

Participants

Participants in the Study were 11 undergraduates from the University of Virginia who received payment of $5.00.

Apparatus and Stimuli

PC computers and monitors were used to run the study. Participants sat approximately 36-48 cm from the screen.

Each experiment presented a single category (e.g., animal, religion, & texture), therefore only clear relationship was affective. Within each category, half of the words

were positive and half were negative. Thus, primes and targets could either be congruent (positive-positive or negative-negative) or incongruent (positive-negative or negative-positive) in affective relation. See Appendix A and B for a list of the word stimuli. Prime and targets were selected at random without replacement. Each prime and target was repeated four times, which lead to 80 trials in all.

Procedure

The participants sat in front of the computer screen and instructions were presented on the monitor. The participants were instructed to ignore the first word (prime) word and to indicate whether the second word (target) was good (9-key) or bad (1-key). After the participants finished reading the instructions, the experimenter made sure that they were clearly understood, and the participants pressed a key to begin the task. Primes were presented for 200 ms followed by a 100 ms blank screen, and then the targets were presented (Bargh et al., 1992). Targets remained on the screen until a response was registered. Incorrect responses were punished by a computer-generated tone.

The participants completed the texture evaluation task, then followed by the religion evaluation task, and lastly performed the animal evaluation task.

Results

The first five trials were treated as practice and removed from the analysis. Trials with incorrect responses were also removed (see below for analysis of error rates). In addition, latencies that were 2 standard deviations below or above the overall group mean were replaced with these values. The cutoff values were 351, 307, and 328ms below the mean and above the mean they were 1453, 2686, and 1849ms (animal, religion, and texture, respectively), which 4% of the trials were replaced.

In Study 3, we thought it likely that we would find affective priming to be significant. To assess this prediction, we computed six latency means for each participant by crossing the within subject factor of affective congruence (congruent vs. incongruent) with the three-level category variable (animals vs. religion vs. textures). The main effect for affective congruence was significant, F (1, 10) = 6.14, $p < .05$. There was also a main effect for category, such that participants responded faster to the words compared to the religion words, F (2, 10) = 9.28, $p < .05$. The interaction was not significant, $F < 1$. Thus, affective priming was statistically equal across the three word lists. Furthermore, the order of presentation did not have a significant effect on the priming effect size, $F < 1$.

A second 2 x 3 ANOVA was performed on accuracy rates. None of the factors were significant, Fs < 1.

Discussion

Affective priming was demonstrated for each list. Therefore, it rules out the possibility that stimulus selection was causing the lack of affective priming. Combining this study with the previous two studies suggests that if dual category relations exist (e.g., Studies 1 & 2) spreading of activation among the category relation is activated by the prime, but the affective dimension is not. Even with an evaluation task, the spreading of activation occurs along the category relation, thus response competition would not occur because the primes relation (category) will not interfere with an evaluative response to the target. In sum, the findings of Studies 1 & 2 suggest that category relations are

automatically processed and affective priming occurs when a dual category relation does not exist, but affective relations do exist as in Study 3.

Study 4

Studies 1, 2, and 3 used words as primes and targets. It is reasonable to think that picture primes might lead to a different pattern of results. For example, picture primes are often used in studies of "unconscious affect" (Murphy & Zajonc, 1993; Ohman & Soares, 1998). Additionally, whereas word meaning requires cortical analysis (Posner & Raichle, 1995), there may be subcortical pathways that can attach meaning to visual images (LeDoux, 1996). Finally, from a threat avoidance perspective, the visual image of a threat (e.g., a visual image of a snake) poses far more serious challenge than its linguistic counterpart (e.g., the word "snake"). It seems likely that "preattentive" processing mechanisms might be especially attuned to visual, rather than linguistic, threats (Ohman, Flykt, & Lundqvist, 2000).

Because affective associations may be more salient with pictures than words (De Houwer & Hermans, 1994), we used picture primes as stimuli within studies 4 and 5. In study 4, we adapted the procedures used in De Houwer & Hermans (1994), which involved superimposing letter strings on top of animal pictures. Participants were asked to ignore the pictures (primes) and to simply classify the superimposed letter strings (targets).

Picture-word pairings were of three types. First, the pair might be congruent in both category membership and affective connotation (e.g., the word "snake" on top of a snake picture). Second, the pair might be affectively congruent, but incongruent in category membership (e.g., the word "snake" on top of a spider picture). Third, the pair might be incongruent in both category and affect (e.g., the word "snake" superimposed on a rabbit picture). A comparison of the first and second conditions reveals whether there is an effect for category congruence, holding affective congruence constant. If there is such an effect, it would mean that participants could not prevent themselves from encoding the category of the picture (e.g., whether it is a snake or a spider). By contrast, a comparison of the second and third conditions reveals whether there is an effect for affective congruence, holding category congruence constant. If there is such an effect, it would mean that participants could not prevent themselves from encoding the affect of the picture (i.e., good vs. bad).

In Study 4, we sought to conceptually replicate both Studies 1 and 2 within the same design. Therefore, participants made lexical decisions (like Study 1) in one-half of the blocks and made evaluations (like Study 2) in the other half. Based on our findings so far, we hypothesized that, regardless of the task at hand – lexical decision vs. evaluation – we would find priming effects for category congruence but not affective congruence. Such a pattern of results would suggest that category precedes evaluation rather than visa versa (Mandler & Shebo, 1983).

Method

Participants

Eighteen participants from the undergraduate psychology pool at the University of Illinois served in the experiment.

Apparatus and Stimuli

Two Kodak Ektapro projectors fitted with Uniblitz high-speed shutters (less than 1 ms error) displayed the stimuli onto a 4 x 4 foot white screen. One slide projector

presented the prime slides, whereas the second presented the target slides. Picture slides were approximately 3 x 3 feet. Letter strings, centered both vertically and horizontally within the picture, were composed of 6 inch white letters of medium thickness.

Prime slides were chosen from 80 unique picture slides. Of these 80 pictures, there were 20 dogs, 20 rabbits, 20 spiders, and 20 snakes. In the evaluation blocks, there were eight target word slides, four of which were positive in affective connotation (puppy, rabbit, swan, and sparrow) and four of which were negative in affective connotation (porcupine, raven, snake, and spider). Of the eight target word slides, four could match the pictures in category membership (puppy, rabbit, snake, and spider), whereas four could not (porcupine, raven, swan, and sparrow). In the lexical decision blocks, the same prime and target stimuli were used. However, there were also eight non-word stimuli that were added as potential target stimuli.

Procedure

The study consisted of four blocks with 48 trials in each block. Participants completed two lexical decision (L) blocks and two evaluation (E) blocks and were randomly assigned to one of the following order conditions: LELE, LEEL, ELEL, ELLE. Within each block, primes were randomly selected, without replacement, from the 80 picture slides. Targets were also selected randomly, without replacement, from among the 8 (evaluate blocks) or 16 (lexical decision blocks) possible stimuli.

Participants were run individually. Upon arrival to the laboratory, the lights were turned off, followed by a 10-minute period of dark adaptation. Before each of the four blocks, participants were told which task – lexical decision or evaluation- was relevant. The task was reinforced with a printed sign (not a word vs. a word or bad vs. good) that was placed on the screen during the trials. They were instructed to ignore pictures and respond to the superimposed letter strings. A response box was used to record responses, four keys were situated in a line, numbered 1 to 4, with 1 and 4 as the outside keys. The 1 and 4 keys were used to either signify a lexical response (word vs. not a word) or an evaluation response (good vs. bad). The keys were randomized for each block. The pictures and words were presented simultaneously and remained on the screen until a response was registered, with approximately 6 seconds between trials.

Results

The first 5 trials of each block were removed due to practice effects. Furthermore, reaction times that were 2 standard deviations below the mean (lexical decision = 370 ms; evaluation = 402 ms) or 2 standard deviations above the mean (lexical decision = 1465 ms; evaluation = 1220 ms) were replaced with these cutoff values. Error trials were excluded from both blocks and non-word trials were excluded from lexical decision blocks.

To assess the effects of category congruence and effective congruence, six means were computed for each participant. As explained above, picture-word pairs could be congruent in both category and affect (match both), congruent in affect but incongruent in category (match affect), or incongruent in both (mismatch both). This three-level, within-subject variable was crossed with task in a 2 (Task: lexical decision vs. evaluation) x 3 (Congruency Type) ANOVA. The analysis revealed a main effect for task (lexical decision = 737 ms; evaluation = 683 ms), F (1, 16) = 4.82, $p < .05$, as well as a main effect for Congruence Type, F (2,32) = 9.23, $p < .01$. There was no interaction between these variables, F (2, 32) = 1.08, $p > .35$, indicating substantially the same

results whether the task involved lexical decisions or evaluations. Means for the Congruence Type main effect are reported in Figure 3.

To more precisely locate the source(s) of priming in the study, we next performed two further ANOVAs. In the first 2 (Task) x 2 (Category Congruence) ANOVA, we compared "match identity" to "mismatch both" latencies to determine whether participants implicitly encoded category information. Again, there was a main effect for task (lexical decision = 731 ms; evaluation = 665), F (1, 16) = 6.55, $p < .05$, as well as a main effect for Category Congruence, F (1, 16) = 16.06, $p < .01$, with no interaction, $F < 1$. Thus, participants implicitly encoded Category information, a tendency that was not affected by the task (lexical decision vs. evaluation).

In the second 2 (Task) x 2 (Affect Congruence) ANOVA, we compared "match affect" latencies to "mismatch both" latencies to determine whether participants implicitly encoded affective information. Although the main effect for task was marginal (lexical decision = 755 ms; evaluation = 704 ms), F (1, 16) = 3.47, $p < .10$, there was no main effect for Affect Congruence, $F < 1$, nor was there a Task x Affect Congruence interaction, F (1, 16) = 1.53, $p > .20$. Thus, holding category constant, there was no affective priming at all, a result that replicates both Study 1 and Study 2.

The accuracy rates were examined in a 2 (Task) x 3 (congruence Type) ANOVA. No significant effects were found, $p > .15$. Thus, no speed-accuracy tradeoffs were apparent.

Discussion

Study 4, within the context of one design, conceptually replicated both Study 1 and Study 2 using picture primes. In the lexical decision task, which removes response competition as a possible explanatory mechanism, we found category priming with no affective priming. This suggests that at least in this task, participants cannot stop themselves from extracting category information; by contrast, the primes affect was not extracted and therefore did not influence the target response. Such a pattern is inconsistent with the idea that crude good/bad distinctions are made before a more refined semantic analysis. Instead, the results suggest that the reverse sequence is a more plausible one (Rolls, 1999).

Furthermore, we were also able to conceptually replicate Study 2. Even in an evaluation task, category information appears to be extracted more automatically than affective information. This provides rather strong evidence for the unconditional nature of cognitive, rather than affective, forms of meaning analysis. In this respect, the results are quite consistent with several literature reviews that have concluded that categorization precedes, rather than follows, the retrieval of affective associations (Schmidt-Atzert, 1988; Storbeck, Robinson, & McCourt, 2002).

Of additional relevance, Study 4 included several procedural details that, in comparison to Studies 1 and 2, could have produced more affective priming. First, primes consisted of pictures rather than words. This is an important variation because several authors have proposed a particularly tight connection between visual images and affective response (Murphy & Zajonc, 1993; Ohman & Soares, 1998). Second, primes and targets were presented simultaneously, a factor that some have argued should lead to stronger affective priming than would occur with a longer delay (e.g., Klauer, 1998). And third, we used prime stimuli that were vivid, detailed, and quite clearly "cute" and pleasant (puppies, rabbits) vs. "slimy" and unpleasant (snakes, spiders). Despite all of

these procedural variations, the results conceptually replicated those of Studies 1 and 2. Thus, the results provide further support for obligatory nature of semantic (when compared to affective) analysis.

Study 5

In study 5, we returned to prime-target procedures of Studies 2 and 3, which had a 300 ms SOA between prime and target. However, in Study 5, we used pictures rather than words, as both primes and targets. Like Study 4, we focused on the factors of Category Congruence (match both vs. match affect) and Affect Congruence (match affect vs. mismatch both). Also like Study 4, we had participants complete two tasks with the slides. In one condition, they were asked to evaluate the target pictures. In another condition, they were asked to categorize the target pictures (e.g., rabbit vs. snake). Based on Study 4 results (as well as those from Studies 1 and 2), we expected a main effect for Category Congruence, but not Affect Congruence.

Method

Participants

Forty-one participants from the University of Illinois psychology subject pool participated in the experiment.

Apparatus and Stimuli

The apparatus was the same as in Experiment 4 except for a few modifications. A third, manual projector was used to display the task onto the bottom half of the screen. For example, one of the task slides read "snake vs. rabbit". The prime slides were the same as in experiment 4. Target slides for Study 4 consisted of the same 80 slides, this time duplicated and placed in the second projector.

Procedure

All participants were run individually after undergoing dark adaptation. The study consisted of 12 blocks of 15 trials each. Six of the 12 blocks concerned evaluation (e.g., good vs. bad), whereas six of the 12 blocks concerned categorization (e.g., rabbit vs. snake).

Blocks were constructed in the following manner. There were four target slides of interest: rabbit, puppy, snake, and spider. Within each block, targets consisted of two of the four stimulus categories (e.g., rabbit vs. snake). In total, there were 6 target pairings (rabbit vs. puppy, rabbit vs. snake, rabbit vs. spider, puppy vs. snake, puppy vs. spider, snake vs. spider). The six target type pairings were crossed with the two tasks – categorization and evaluation – producing the 12 blocks of interest.

Prior to each block, the computer selected one of the twelve blocks at random. The computer also determined, at random, which key would correspond to which judgment. Based on these considerations, the computer would instruct the experimenter which manual slide to present from a third projector. In the evaluation blocks, there were two possibilities (good = 1 and bad = 4 or bad = 1 and good = 4). In the categorization blocks, similarly, there were two possibilities for each pair of target types (e.g., rabbit = 1 and snake = 4 or snake = 1 and rabbit = 4). The task slide was displayed before the block and participants were given enough time to orient to the task at hand.

In all trials, primes were selected at random, without replacement, from among the 80 slides in the prime slide tray. That is, in all blocks, a prime slide could be rabbit, a puppy, a snake, or a spider. Within a given block, targets consisted of only one of two

types (e.g., rabbit vs. snake). Target slides were selected at random, without replacement, from among the 40 relevant slides in the target slide tray.

Participants were instructed to ignore the prime slide and respond to the target slide. For each trial, a prime slide was presented for 200 ms, followed by a 100 ms blank, and then the target slide. The target slide remained on the screen until a response was registered via the response box. There was a delay of approximately 6 seconds in between trials.

Results

Because, there were only 15 trials per block, all correct responses were retained. Error trials were excluded. Latencies that were two standard deviations below (279.5) and two standard deviations above (1210.5) the overall mean were replaced with these values. (The same cutoffs were used for both tasks because there was no task main effect -- see below)

Prior to obtaining means, we dropped two of the evaluation blocks (spider vs. snake and puppy vs. rabbit) because such blocks required the same response ("good" for puppy vs. rabbit and "bad" for snake vs. spider) throughout the entire block. In these blocks, then, participants did not need to encode the target stimulus in any meaningful way to make a judgment. Although we decided to drop these two blocks, we note that exactly parallel results emerge when they are included.

As in Study 3, there were three possibilities of interest -- match both vs. match affect vs. mismatch both -- depending on prime-target combination. This three-level Congruence Type variable was crossed with Task (categorization vs. evaluation), resulting in 6 means per participant. Accordingly, our first analysis consisted of a 2 (Task) x 3 (Congruence Type) ANOVA. There was a main effect for Congruence Type, $\underline{F}$ (1, 40) = 17.02, $\underline{p}$ < .01, but no main effect for Task, $\underline{F}$ < 1, and no interaction, $\underline{F}$ (2, 80) = 1.14, $\underline{p}$ > .30. The main effect for Congruence Type is graphically displayed in Figure 4.

As in Study 4, we next performed two analyses to determine the locus of the Congruence Type main effect. We first contrasted "match both" vs. "match affect" latencies in a 2 (Task) x 2 (Category Congruence) ANOVA. As expected, there was main effect for Category Congruence, $\underline{F}$ (1, 40) = 30.26, $\underline{p}$ < .01, but no main effect for Task, $\underline{F}$ < 1, and no Task x Category Congruence interaction, $\underline{F}$ < 1. Thus, people extracted semantic information from the primes even though they were instructed to ignore them.

We next contrasted "match affect" vs. "mismatch both" latencies in a 2 (Task) x 2 (Affect Congruence) ANOVA. Once again, there was no main effect for Affect Congruence, $\underline{F}$ (1, 40) = 1.02, $\underline{p}$ > .30. The Task main effect, $\underline{F}$ < 1, and Task x Affect Congruence interaction, $\underline{F}$ < 1, were also not significant. Thus, we once again obtained no hint of affective priming.

Discussion

Study 5, like Study 4, included two tasks as a way of determining whether affective priming is modulated by the task at hand. Although Study 4 offered a hint that there was stronger affective priming effect in the evaluation task than in the lexical decision task (see footnote 1), this evidence was weak at best. Furthermore, Study 5, which included categorization and evaluation tasks, did not produce any hint of affective priming in either of the tasks. Therefore, the results are fairly consistent in suggesting

that the same information is extracted from prime stimuli regardless of one's processing goals.

More important from a comparative perspective, experiment 5 added further evidence for the relatively stronger tendency to encode semantic over affective information. Even though participants were instructed to ignore the primes, they nevertheless could not do so with regard to the prime's semantic content. Furthermore, this effect held equally for categorization and evaluation tasks, suggesting that semantic analysis is relatively obligatory, regardless of the task at hand. The same conclusion cannot be made concerning affective information. Indeed, there was strikingly little evidence for affective priming.

General Discussion

In four studies, we systematically compared semantic vs. affective priming. Comparisons were made across three types of tasks (lexical decision, categorization, and evaluation) for two types of primes (words and pictures) as well as two types of targets (words and pictures). Two different SOAs (simultaneous or 300 ms) were used across the four studies. Despite these variations from study to study or task to task, the results were quite consistent and robust. Semantic priming repeatedly emerged, whereas affective priming did not. However, study 3 did demonstrate affective priming when semantic content was held constant (i.e., category membership). Therefore, results from studies 1 & 2 cannot be due to the stimulus materials. In total, the findings support the view that semantic analysis precedes affective analysis at encoding (see also Storbeck et al., 2002).

A Comparative Approach

Both Bargh (1997) and Zajonc (1980) have argued that affective information is extracted unconsciously and, furthermore, that affect is encoded prior to semantic information. Consistent with these claims, there is now sufficient evidence to conclude that affect can be elicited by subliminal stimuli (Murphy & Zajonc, 1993; Öhman & Soares, 1998; Robinson, 1998). However, semantic meaning can also be elicited by subliminal stimuli (Abrams, Klinger, & Greenwald, 2002; Naccache & Dehaene, 2001). Thus, showing that affect can be elicited unconsciously is not sufficient for concluding that affect precedes semantic analysis in stimulus encoding (for a similar critique, see Lazarus, 1999).

Given the previous evidence that both semantic and affective factors play some role in encoding objects, an interesting question is how these two types of priming relate to each other. Although investigators have offered a number of hypotheses about the possible relations, critical comparative data has often been lacking. One reasonable proposal is that all objects are first evaluated (crudely) as good or bad before a more detailed semantic analysis occurs. Such a proposal may be somewhat consistent with LeDoux's (1996) idea that affective analysis offers a "quick-and-dirty" route to object appraisal that is later modified on the basis finer semantic distinctions. This proposed relationship between category-based vs. affective encoding should reasonably produce more robust affective priming than semantic priming. Clearly the results presented here are inconsistent with this hypothesis. However, the data is consistent with new data that argues the low-route is not accessed during normal processing (i.e., no insult or lesion) and cortical processing is needed in discrimination conditioning (Storbeck, in prep). Moreover, neurological models of visual processing are also inconsistent with crude

evaluator as identification and categorization within the visual cortex typically occur before, rather than after, differentiated processing by the amygdala (Rolls, 1999; Storbeck et al., 2002).

Another reasonable proposal is that semantic and affective features are processed in parallel. For example, in one location, a snake would be tagged as a snake; in another, it would be tagged as a negative object. Such a proposal should generally assume that semantic and affective priming are additive. The present results are inconsistent with this hypothesis. Specifically, when prime-target relations differed according to both semantic and affective congruence, only semantic congruence mattered. From our point of view (see also Storbeck et al., 2002), it seems unlikely that the brain would form two non-interactive codes – one related to category membership and one related to valence – for the same object. Both must ultimately rely on one prior source of knowledge, namely initial processing within the visual cortex (Storbeck et al., 2002). In this respect, object encoding relies on interactive neural circuits rather than isolated modules that do not feed into each other (Posner & Raichle, 1994).

A third reasonable proposal is that semantic and affective qualities are encoded interactively. That is, objects may be encoded as semantic/affective hybrids like "bad animals" on the one hand and "good animals" on the other. Such a proposal should hypothesize that semantic and affective priming would interact such that the largest degree of priming occurs for prime-target combinations that are congruent in both category membership and affect (e.g., both bad animals). In Studies 1 and 2, we were able to independently vary category membership and affect; thus, we were also able to determine if there was an interaction between these two forms of priming. There was no hint of an interaction in these studies. Furthermore, Studies 4 and 5 found no priming from one bad animal (e.g., snake) to another (e.g., spider). We suggest that, although there may indeed be clusters in long-term memory to represent "good animals" on the one hand and "bad animals" on the other, such clusters are secondary to more molar considerations (such as whether the object is an animal or not). By this reasoning, initial encoding tendencies may be limited to simple semantic distinctions such as whether the object is animate or not. Only later in the encoding sequence do bad animals get separated from good ones.

These considerations suggest a particular relationship between semantic and affective aspects of encoding, one in which semantic features must first be encoded before retrieving affective associations (see also Storbeck et al., 2002). This proposal is entirely consistent with the data. Note that such a proposal assumes that, given a priming task without response compatibility issues (e.g., a lexical decision task), semantic priming will tend to be more robust than affective priming. Such a hypothesis also appears to be consistent with prior data in that the evidence favoring spreading activation within the semantic priming literature (e.g., Neely, 1991) is stronger than the evidence favoring spreading activation within the affective priming literature (e.g., Klauer, 1998). Although prior reviews had suggested that this might be the case (e.g., Klauer & Musch, in press), the comparative studies reported here were able to flesh this pattern out in more detail.

It is worth pointing out that our analysis does not preclude affective priming, even that based on spreading activation. Indeed, we view it likely that long-term memory contains clusters such as "good animals" and "bad animals". However, both of these

clusters follow an initial distinction in terms of whether the object is an animal or not. Because such clusters would tend to be smaller and closer together (i.e., both good and bad animals are within a larger animal cluster), affective priming will tend to be smaller than semantic priming. Additionally, affective priming may disappear altogether if the person terminates the encoding process before complete recognition, as would be expected to happen with irrelevant short duration primes.

As for Study 3 in which we eliminated the dual categories, affective priming was produced. This argues that with a singular category, the category was automatically activated throughout the task, and thus was more adapt to activating concepts within the animal category, such as "good animals". However, when dual categories exist (e.g., animals vs. textures), semantic analysis is encoded and the prime serves to activate one of the categories and inhibits the other or encoding is stopped due to the short duration prime. This then would inhibit "good textures" if the prime activates the animal category, reducing the relation between "good animals" and "good textures". This argues that when semantic analysis can occur, it will, but as soon as the semantic analysis is limited (singular category such as in Study 3), then affective information is encoded, because the singular category remains active instead of being inhibited by a secondary category.

Prior to the current studies, we were aware of only a handful of priming studies that have explicitly adopted a comparative approach. In one prior study, Klinger et al. (2000) found semantic, but not affective, priming in a semantic judgment task. However, they found affective, but not semantic, priming in an evaluation task. Thus, priming was only elicited when the task at hand – semantic or affective – matched the prime-target relationship (i.e., congruent vs. incongruent). It is likely that procedural differences are the underlying reason for the discrepant results in their investigation vs. ours. Their study involved subliminal presentation along with a response window procedure. The combination of factors may seriously limit spreading activation, which builds up over the course of hundreds of milliseconds, from occurring. By contrast, response competition is typically maximal when primes and targets occur in very close proximity in time (e.g., 0 ms SOA). Thus, the fact that the Klinger et al. (2000) study found priming that was entirely consistent with response compatibility principles is not surprising. Because our participants were shown above-threshold primes and allowed sufficient time to support high accuracy rates, the primes in our studies likely received more semantic analysis (Meyer, Irwin, Osman, & Kounios, 1988).

The Priority of Semantic Analysis

Several behavioral studies are in agreement with our findings in suggesting that semantic analysis typically precedes affective analysis. In several papers, for example, De Houwer et al. (1994; 1998) have found identity priming, but not affective priming, within the pronunciation task. In the same papers, however, they obtained both identity and affective priming within an evaluation task. In another relevant study, Kemp-Wheeler et al. (1992) found semantic, but not affective, priming in a pronunciation task. In the same paper, however, they also found both semantic and affective priming in a lexical decision task. On the basis of the idea that the pronunciation task is a relatively pure index of semantic activation (e.g., Balota & Lorch, 1986), both sets of authors suggested that affective meaning is parasitic, or dependent, on semantic meaning, a suggestion that is obviously consistent with our data.

The semantic priming effect was initially used to study the structure of long-term memory. Although there have been some controversies in the literature, most investigators now conclude that semantic priming in lexical decision and pronunciation tasks reflects spreading activation from one concept to another (McRae & Boisvert, 1998; Neely & Kahan, 2001; Thompson-Schill, Kurtz, & Gabrieli, 1998). Two principle implications follow from this. One, such tasks *do* inform us concerning the structure and organization of long-term memory. And two, such effects occur regardless of the task at hand or the person's intentions. The initial, as well as subsequent, work on affective priming borrowed these two assumptions. That is, they assumed that (a) valence must be represented in the structure of long-term memory and (b) affective priming occurs regardless of a person's intentions. We suggest, along with others (especially Klauer & Musch, 2002; Klauer & Musch, in press), that the latter assumptions may generally be less valid with respect to affective (than with respect to semantic) priming. In particular, we believe that it is mistaken to assume that "good" and "bad" represent some kind of huge nodes in memory in the same way that animate objects and non-animate objects likely do. Also, we believe that it is mistaken to assume that spreading activation is the primary mechanism mediating affective priming.

Moving to the literature on priming and social judgment, Erdley and D'Agostino (1988) were interested in the question of whether subliminal priming produces target judgments that are construct-specific or more broadly evaluative. To test this comparative question, they primed concepts like "honesty" and then asked participants to judge targets along semantically related dimensions (e.g., "trustworthy"), as well as along semantically unrelated, but evaluatively consistent, dimensions (e.g., "friendly"). Their results were unambiguous in suggesting that subliminal priming activates semantic meaning rather than global affective reactions.

Relevant findings also come from the face processing literature. For example, Schyns and Oliva (1999) had participants engage in three different categorization tasks with hybrid faces as stimuli. Participants were asked to judge the faces according to sex (a semantic distinction), presence or absence of emotional expression, and type of emotional expression. Consistent with the idea that semantic analysis typically precedes affective analysis, they found that classification by sex was the fastest. That is, a face must be categorized in a non-affective way (e.g., by sex) before one can determine its affect. Converging evidence comes from an ERP study of face processing. Specifically, Potter and Parker (1997) compared ERPs to determine how quickly people can discriminate faces based on identity information vs. its emotional expression. The results indicated that people can encode identity-related information before they can encode emotional expressions.

Indeed, several recent ERP studies suggest that components of identification and semantic classification can occur surprisingly soon after stimulus exposure. Seeck et al. (1997) found that ERPs could discriminate old vs. new faces after only 50-70 ms of stimulus exposure. Van Rullen and Thorpe (2001) found category-related ERP distinctions after only 70-80 ms. By contrast, ERP recordings suggest that people begin to distinguish emotional facial expressions around 100-120 ms (Halgren et al., 2000). Furthermore, the same data suggest that the amygdala on average begins to respond to emotional expressions around 120 ms (Halgren et al., 2000). The latter finding is particularly important given our knowledge concerning the amygdala's role in evaluation

(see Lane & Nadel, 2000, for a review). The results certainly suggest that evaluation typically comes after some initial semantic analysis.

In a recent paper, we (Storbeck et al., 2002) performed a more extensive review of studies relevant the encoding of visual stimuli. Briefly, we suggested that the data were consistent with the idea that semantic distinctions have to be made before affective associations (to the object) can be retrieved. In this connection, a particularly important milestone in visual processing is the achievement of object invariance, meaning that distinct views of an object give rise to an identical pattern of neural firing. This achievement (by the inferior temporal cortex) suggests that the brain has identified and matched the retinal image to an idealized template for the object in question. This requires extensive use of semantic memory and constitutes an initial form of object identification (Booth & Rolls, 1998; Desimone et al., 1984). Furthermore, a study has shown that the human homologue of area IT (area LO) can be active without visual awareness of the object (Goebel, Muckli, Zanella, Singer, & Stoerig, 2001). This suggests that when masking procedures are used, area IT can still be activated and consequently still process and identify the object correctly, even though at a reduced capacity (Tovee, 1998). Electrophysiological studies establish that object invariance typically happens within 100 ms after stimulus exposure (Rolls & Tovee, 1994). Although the inferior temporal cortex appears to be involved in stimulus identification, it is not affected by the hedonic value of stimuli (Rolls, 1999). Instead, careful physiological as well as behavioral work suggests that affective value is not computed until area IT sends its information forward within the brain, particularly to the amygdala (Fukuda et al., 1987; Nishijo et al., 1988).

In sum, we argue that people cannot determine how they feel about an object until they know what it is. This knowledge need not be conscious, however, as processing within the inferior temporal cortex is very unlikely to have a conscious correlate. In one particularly interesting test of the dependence of affect on prior semantic analysis, Fukuda et al. (1987) cooled the inferior temporal cortex but left the amygdala intact. Consistent with the idea that the amygdala was dependent on the meaning analysis of the inferior temporal cortex, neurons within the amygdala were less able to distinguish rewarding (i.e., food) from non-rewarding stimuli after the inferior temporal cortex had been cooled. These results are rather dramatic in suggesting that affective analysis is typically dependent on some prior semantic analysis.

Conclusion

Very little work has focused on the relative strength of semantic and affective priming, particularly under conditions that are sensitive to spreading activation. In four studies that orthogonally manipulated semantic and affective aspects of the prime-target relationship, we found robust support for semantic priming with very little support for affective priming. Additional Study 3 suggested that affective priming may be more likely when semantic distinctions are minimal. Both sets of findings point to the idea that semantic distinctions occur earlier than affective distinctions in the encoding process. Indeed, we suggest that people must be able to identify and categorize stimuli before they can retrieve affective preferences.

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Appendix A

Word Stimuli for Study 1

	Categories			
Valence	Religion		Animals	
Positive	angel	blessing	butterfly	dove
	deity	heaven	duck	giraffe
	holy	nirvana	kitten	panda
	pious	purity	pony	puppy
	sacred	saintly	rabbit	swan
Negative	devil	evil	leech	rat
	hell	pitchfork	raven	shark
	purgatory	satan	skunk	snake
	sins	torture	spider	squid
	vice	underworld	vulture	worm

Note. Non-words were armo, belfiss, burdel, corfer, corph, dete, fandet, filt, geedon, glarder, groad, heas, horvist, huip, lobut, meckop, mesic, moniph, neaper, papen, pipul, pleng, plodin, powne, refrone, rige, rinder, roat, secard, seshon, setage, shalk, shrast, siffle, sterp, tamg, tift, trassic, wheden, yerd.

Appendix B
Word Stimuli for Study 2

	Categories			
Valence	Textures		Animals	
Positive	creamy	delicate	butterfly	dove
	fluffy	gentle	duck	giraffe
	satin	silky	kitten	panda
	smooth	soft	pony	puppy
	supple	velvet	rabbit	swan
Negative	abrasive	bumpy	leech	rat
	coarse	grainy	raven	shark
	harsh	sharp	skunk	snake
	jagged	rocky	spider	squid
	scratchy	tough	vulture	worm

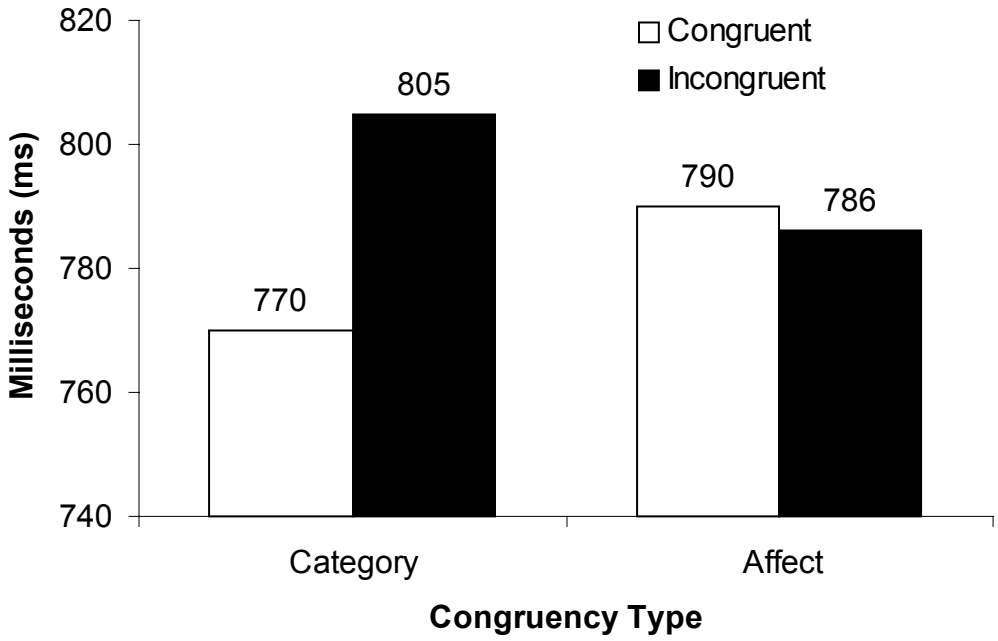
Footnotes

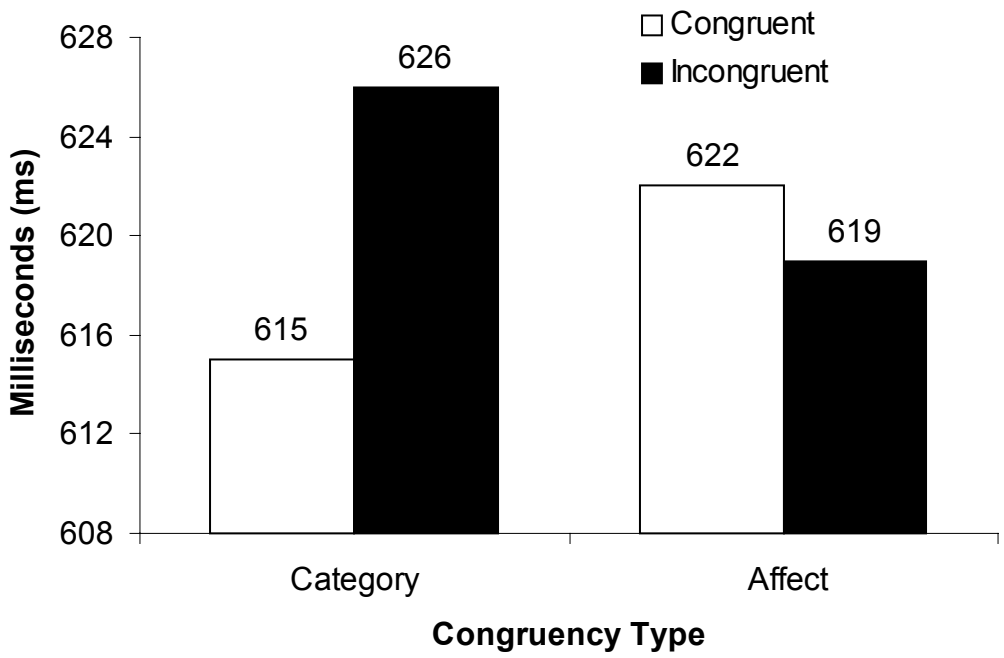
1. Note that our categories (e.g., animals vs. textures) were broader in Studies 1 and 2 than in Study 4 (e.g., dogs vs. snakes). We used narrower categories in Studies 4 and 5 because of the use of pictures, rather than words, as priming stimuli. In this connection, it was relatively easy to find 20 pictures of different dogs (e.g., beagles, poodles, etc.), rabbits, snakes, and spiders that involved similar composition, lighting and background.

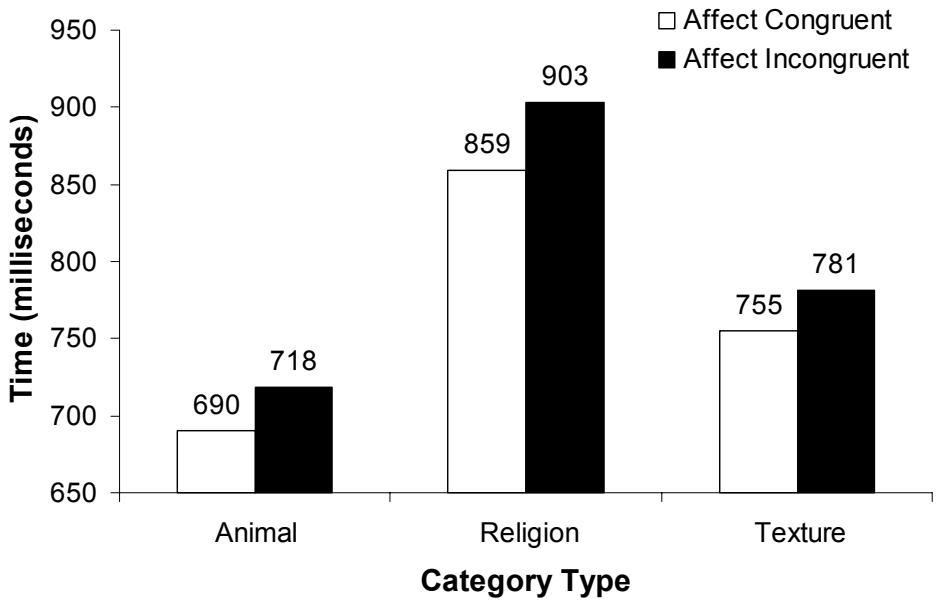
2. In none of the analyses was there a significant Task x Congruence type interaction. This means that the same pattern -- Category priming with no affective priming -- characterized both tasks equally. However, in light of previous suggestions that affective priming is more likely in evaluation task than in other types of tasks (Fazio, 2001; Klauer & Musch, 2001), we performed additional ANOVAs for each task separately. Considering the pairwise comparisons of primary interest, there was a main effect for Category Congruence, $\underline{F}$ (1, 16) = 5.02, $\underline{p} < .05$, but not Affective Congruence, $\underline{F} < 1$, in the lexical decision task. In the evaluation task, however, the pattern was different. In this task (considered alone), there was a main effect for Category Congruence, $\underline{F}$ (1,16) = 19.93, $\underline{p} < .01$, as well as a main effect for Affective Congruence, $\underline{F}$ (1, 16) = 5.25, $\underline{p} < .05$. Thus, the data provide some hint of support for the idea that affective priming is stronger in the evaluation task. However, given the lack of a Task x Congruence Type interaction, we are reluctant to make much of this finding, particularly since it was not conceptually replicated in Study 5.

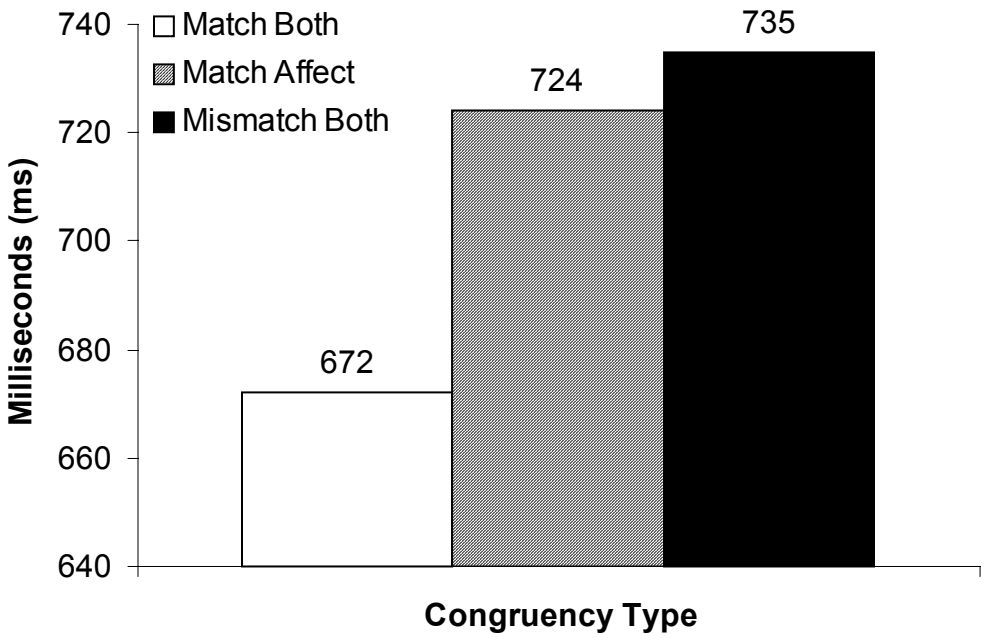
3. We also performed separate analyses for each task -- categorization and evaluation -- separately. For the categorization task, there was a main effect for Category Congruence, $\underline{F}$ (1, 40) = 11.13, $\underline{p} < .01$, but not Affective Congruence, $\underline{F}$ (1, 40) = 1.44, $\underline{p} > .20$. Similarly, for the evaluation task, there was a main effect for Category Congruence, $\underline{F}$ (1, 40) = 18.12, $\underline{p} < .01$, but not Affect Congruence, $\underline{F} < 1$. In sum, regardless of the task at hand, people appeared to extract category-related, but not affective, information from the primes.

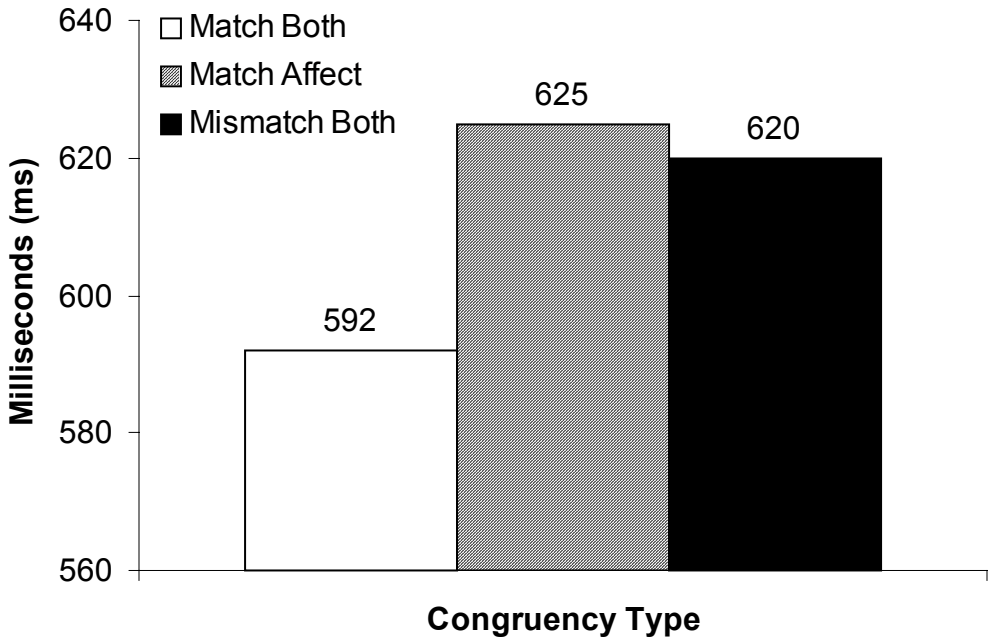
Figure 1. Mean latencies by Congruency Type, Study 1.
Figure 2. Mean latencies by Congruency Type, Study 2.
Figure 3. Mean latencies by Affective Congruency and List, Study 3
Figure 4. Mean latencies by Congruency Type, Study 4.
Figure 5. Mean latencies by Congruency Type, Study 5.


820
800
780
760
740
Milliseconds (ms)
Congruent
Incongruent
805
790
786
770
Category
Affect
Congruency Type


Congruent
Incongruent
628
624
620
616
612
608
Milliseconds (ms)
626
622
619
615
Category
Affect
Congruency Type


Affect Congruent
Affect Incongruent
950
900
850
800
750
700
650
Time (milliseconds)
690
718
859
903
755
781
Animal
Religion
Texture
Category Type


740
720
700
680
660
640
Match Both
Match Affect
Mismatch Both
672
724
735
Milliseconds (ms)
Congruency Type


640
620
600
580
560
Milliseconds (ms)
Match Both
Match Affect
Mismatch Both
592
625
620
Congruency Type