Preferences and Inferences in Encoding Visual Objects: A Systematic Comparison of Semantic and Affective Priming

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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. The authors orthogonally varied both the semantic and affective relations between primes and targets. In both studies, semantic priming but not affective priming was found. Study 3 revealed that the same stimuli can produce affective priming, but only when words come from a single 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.

Keywords: *affect; evaluation; categorization; 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, 2003). It is also true that in the pursuit of automatic affect, investigators have often ignored the fact that a variety of nonaffective (i.e., perceptual, semantic) 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 one hand, and affective processes, on the other. Second, it is of interest to determine whether semantic or affective priming is 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 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

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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.

Affective Priming: Evidence and Mechanisms

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 Stimulus Onset Asynchrony [SOA] ms) prime of similar valence. For example, the prime word *grumpy* might facilitate an evaluative response to the target word *disgust*, relative to the target word *sunshine* (see Klauer, 1998). 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.

A number of studies have produced affective priming (for reviews, see Bargh, 1997; Fazio, 2001; Klauer & Musch, 2003). However, the underlying mechanism, if there is a primary one, is unclear. Three prominent accounts of affective priming propose three nonoverlapping mechanisms, one specific to a spreading activation mechanism (Bargh, 1997), one specific to response competition (De Houwer, Hermans, Rothermund, & Wentura, 2002; Klauer, 1998), and one specific to an affective matching principle (Klauer & Musch, 2002; Wentura, 2000).

Bargh (1997) has proposed a spreading activation account for affective priming. According to this account, the valence of a prime activates a general purpose evaluation node, either one specific to positive objects or one specific to negative objects. The activation of one of these nodes, in turn, speeds the encoding of like-valence objects. Several results suggest that a spreading of activation account of affective priming is likely to encounter difficulties, at least as an exclusive explanation. In particular, there is some agreement that affective priming is more robust in the evaluation task than in tasks (e.g., lexical decision, pronunciation) that do not depend on evaluating targets (Klauer & Musch, 2003). For example, in attempting to replicate the results of Bargh, Chaiken, Raymond, and Hymes (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.

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 (Kornblum, Hasbroucq, & Osman, 1990). 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 relative to good-bad or bad-good), the response would be faster. The important point here is that response compatibility effects are quite common when the task is designed so that irrelevant stimuli (i.e., primes) would be associated with a correct response (e.g., good or bad) to the target (Kornblum et al., 1990). Stated this way, affective priming would not be uniquely affective in nature or due to spreading activation but rather would be a specific case of a more general response compatibility mechanism (De Houwer, 2003; Klauer & Musch, 2003; Wentura & Rothermund, 2003).

A response competition mechanism, however, cannot explain the results of several studies suggesting that affective priming sometimes 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 for 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 toward an affirmative response, which would speed positive (i.e., word) responses in the lexical decision task (LDT). There is support for this mechanism (e.g., Klauer & Musch, 2002; Wentura, 2000; Wentura & Rothermund, 2003).

In summarizing, it is useful to compare the mechanisms involved in affective and semantic priming. 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 (Lucas, 2000; McRae & Boisvert, 1998; Neely, 1991). By contrast, the evidence favoring such a mechanism in affective priming is weaker (Klauer, 1998; Klauer & Musch, 2003). Response competition is a mechanism common to both forms of priming (Klauer & Musch, 2002; Klinger, Burton, & Pitts, 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 postlexical mechanisms also have been proposed to account for semantic priming (see Neely, 1991, for a review). On balance, then, it may be that semantic priming is typically a more robust tendency than affective priming, particularly under task conditions that minimize response competition and postlexical strategies.

The Present Studies: A Comparative Approach

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 first be classified according to a crude good/bad distinction (Bargh, 1997). This possibility would tend to favor affective priming as the more robust phenomenon. By contrast, objects may be classified primarily according to semantic categories relative to affective meaning (Rolls, 1999; Storbeck & Robinson, 2003). This possibility would tend to favor semantic priming as the more robust phenomenon. Alternatively, 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). A systematic comparison of semantic and affective priming, then, would seem to be a valuable tool for determining how objects are encoded and represented in memory.

To investigate the alternative predictions mentioned above, a comparative approach is necessary. To this end, we selected stimuli in such a way that valence and category membership could be independently varied. For example, a prime *puppy* and a target *smooth* share an affective relationship (e.g., good) but lack a category relationship (i.e., animal vs. texture). 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 primes. Studies 1 and 4 use an LDT, Study 5 uses a categorization task, and Studies 2, 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.

STUDY 1

In the semantic priming literature, the LDT has been useful in studying spreading activation (Neely, 1991). Typically, the LDT requires a participant to judge the target as a word or not while ignoring the prime. 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, 2003). Because response competition factors do not play a role in the LDT, it should be a useful task for measuring spreading activation related to affective and semantic factors (Neely, 1991).

Method

PARTICIPANTS

Forty-six University of Illinois undergraduates from the psychology subject pool participated for class credit.

APPARATUS AND STIMULI

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

Prime stimuli were words selected at random, without replacement, from a 2 (category: religion vs. animal) 2 (affect: good vs. bad) design. Word targets also were selected at random without replacement from the same list and from an additional list of nonword 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 (half positive, half negative) and 20 animal words (half positive, half negative) (see the appendix for a list of the word stimuli). Each target word was repeated twice, creating 80 trials that required a word response. Forty nonword targets also were repeated twice, for a total of 80 nonword trials.

To confirm that our a priori affective classification of words was correct, we asked 20 participants to rate the valence of the words used in Studies 1, 2, and 3. They did so using a 7-point (1 = *bad*, 7 = *good*) scale. We collapsed across raters to get a mean evaluation for each word. Ratings indicated that good (M = 5.86) and bad (M = 2.32) animal words differed in valence, $F(1, 19) = 158.19$, $p < .000$, as did good (M = 6.00) and bad (M = 1.79) religion words, $F(1, 19) = 178.08$, $p < .000$, and good (M = 5.83) and bad (M = 2.64) texture words, $F(1, 19) = 160.47$, $p < .000$. (Texture words were used in Study 2 but not Study 1.)

PROCEDURE

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 not by pressing the 9 key or the 1 key, respectively. Primes were presented for 200 ms followed by a 100-ms blank screen and then the target (Neely, 1991). Targets remained on the screen until a response was registered. Incorrect responses were punished by a computer-generated tone.

Results

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

Based on our theoretical analysis, we thought it likely that we might find semantic, but not affective, priming in Study 1. To assess predictions derived from this hypothesis, we computed four latency means for each participant, two for category congruence (congruent vs. incongruent) and two for affective congruence (congruent vs. incongruent). As predicted, a 2 (category congruence) 2 (affective congruence) ANOVA revealed a main effect for category congruence on mean latencies, $F(1, 45) = 5.87$, $p = .02$. By contrast, there was no main effect for affective relation, $F < 1$, and the interaction was also not significant, $F(1, 45) = 1.18$, $p = .28$. Thus, the results indicate the presence of semantic, but not affective, priming (see Figure 1 for the relevant means).

A second 2 2 ANOVA was performed on accuracy rates. Of interest, rather than revealing a speed-accuracy trade-off, the results yielded complementary evidence for semantic priming. Specifically, participants were more accurate in classifying targets as words if primes and targets were congruent ($M = .954$) in category relation rather than incongruent ($M = .938$), $F(1, 45) = 7.27$, $p < .05$. By contrast, there was no main effect for affective congruence, and there was not an interaction, *F*s < 1.

Discussion

The LDT with a short SOA, particularly because it does not systematically vary the response compatibility of primes and targets, is thought to be a relatively pure indicator of spreading activation (Neely, 1991). If so, the results of Study 1 are relatively unambiguous in suggesting that semantic, but not affective, priming is mediated by spreading activation. In this respect, our results add to prior ones in suggesting that affective priming is not based on associative connections within long-term memory (Klauer et al., 1997), whereas semantic priming is (Neely, 1991).

STUDY 2

Study 2 was designed to extend the findings of Study 1 with reference to the evaluation task. Prior reviews of affective priming (Klauer, 1998) might lead us to expect more affective priming in Study 2 than in Study 1, precisely because Study 2 used an evaluation task. However, to the extent that evaluation is dependent on a semantic analysis of stimuli, we might expect semantic priming under these same task conditions. In sum, Study 2 seeks to compare affective and semantic priming in a task that should, because of the goal to evaluate and response competition factors, favor affective priming.

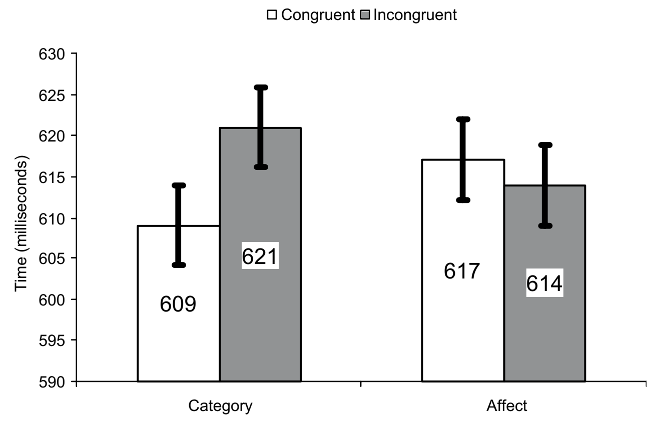

Figure 1 Mean latencies by congruence type, Study 1.

Method

PARTICIPANTS

Forty-three participants from the University of Illinois received payment of $7 for their participation.

APPARATUS AND STIMULI

Between two and four students at a time participated. The computer setup was the same as in Study 1. The prime and target stimuli consisted of animal and texture words (see Study 1 for mean evaluation ratings of the word stimuli) (see the appendix for a list of stimuli).

PROCEDURE

The procedures were the same as in Study 1 except participant's task was to evaluate each target word by hitting the 1 key (bad) or the 9 key (good). The prime and target words were selected at random from a 2 (animals vs. textures) 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 Study 1, the first five trials were considered practice, and trials with an incorrect response were removed (approximately 5%). Latencies of 2 standard deviations below (340 ms) or above (1,730 ms) the overall mean were replaced with these cutoff values (4% of trials).

The mean latencies were examined as a function of a 2 (category congruence) 2 (affective congruence) ANOVA, as in Study 1. This analysis yielded a main effect for category congruence, $F(1, 42) = 14.05$, $p = .001$; no main effect for affective congruence, $F < 1$; and no interaction, $F(1, 42) = 3.31$, $p = .08$. Thus, when the 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 Study 1, accuracy rates were not affected by semantic congruence, $F(1, 42) = 1.63$, $p = .20$; affective congruence, $F < 1$; or the interaction between these two variables, $F < 1$.

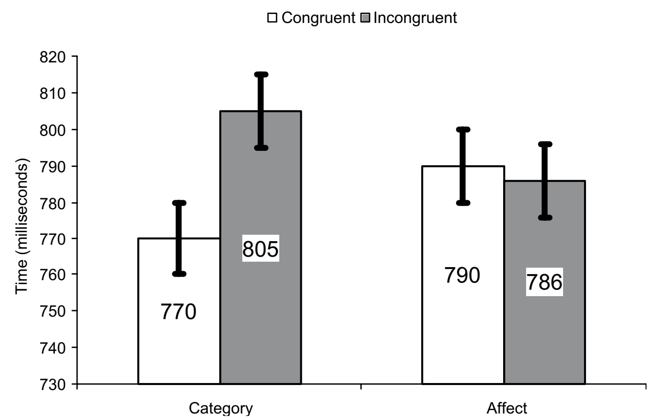

Figure 2 Mean latencies by congruence type, Study 2.

Discussion

The results of Study 2, similar to the results of Study 1, are surprisingly unambiguous. In both studies, semantic priming occurred but affective priming did not. 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, 2003). Despite conditions favoring affective priming, semantic priming still proved to be the dominant encoding tendency.

STUDY 3

We did not obtain affective priming in Study 1, which used the LDT. Perhaps these results are not too surprising in light of frequent failures to obtain affective priming in tasks that rely heavily on spreading activation (Klauer & Musch, 2001). However, it was somewhat more surprising that we did not find affective priming in the evaluation task. Our stimuli are clearly evaluative, as established by the norming data reported in Study 1. Thus, we do not think that the particular stimuli that we used precluded affective priming.

Instead, we thought it likely that there was another systematic factor preventing affective priming in Study 2. Specifically, variations in semantic category (i.e., animals vs. textures) were roughly comparable to variations in affective connotation. If stimuli systematically vary in semantic category membership (e.g., Study 2), and semantic categorization precedes the retrieval of affective associations (Rolls, 1999; Storbeck & Robinson, 2003), then initial classifications in terms of semantic category membership may be deemed sufficient; that is, the person having determined that the word represents an animal or a texture-related adjective may curtail further preattentive processing, thus stopping it before a word's affective valence is determined. In this case, there would be no affective priming, but there would be semantic priming. Clearly, the results of both studies are consistent with this model.

In examining these speculations, the goal of Study 3 was to determine whether the primes used in Studies 1 and 2 could lead to affective priming when there is no systematic variation in semantic category membership. That is, if we eliminate the salient semantic categories, would affective priming occur? To examine this prediction, we asked participants to perform the evaluation task within the context of stimuli drawn from only one of the three semantic categories (animals, religion, or texture) used in Studies 1 and 2.

Method

PARTICIPANTS

Eleven participants from the University of Virginia received payment of $7 for their participation.

APPARATUS AND STIMULI

The computer setup was the same as in Study 1. Within each program, words were drawn from only one of the semantic categories used in Studies 1 and 2 (see the appendix). Within each program, half of the words were positive and half were negative. Because primes and targets were both randomly selected (without replacement), an equal number of trials were affectively congruent or affectively incongruent. Each program had 80 trials.

PROCEDURE

The procedures were the same as in Study 2; participant's task was to evaluate each target word by hitting the 1 key (bad) or the 9 key (good). Each participant completed three programs, one specific to textures, one specific to religious words, and one specific to animals.

Results

The first five trials were treated as practice and removed from the analysis. Trials with incorrect responses also were removed (error analysis are reported below). In addition, latencies that were 2 standard deviations below (300 ms) or above (animal: 1,825; religion: 3,249; texture: 2,198 ms) the task mean were replaced with these values (4% of trials).

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). As expected, the main effect for affective congruence was significant, $F(1, 10) = 6.78$, $p = .026$. There was also a main effect for semantic category, such that participants evaluated animal and texture words faster than religious words, $F(2, 9) = 8.61$, $p = .008$. The interaction was not significant, $F < 1$. Thus, affective priming was statistically equal across the three word lists (see Figure 3). Furthermore, the order of the lists did not influence affective priming, $F < 1$.

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

Discussion

The results of Study 3 indicate that the stimuli used in Studies 1 and 2 are capable of eliciting affective priming, at least within the evaluation task. However, the results of Study 3, considered in combination with the prior studies, point to the contextual nature of the affective priming effect. When primes differ in their semantic category membership, semantic priming, but not affective priming, occurs. When primes do not differ in their semantic category membership, affective priming does occur. The results, in sum, suggest that encoding visual objects with respect to their affect is far from obligatory. Rather, people may only retrieve affective associations when initial analyses in terms of semantic category membership yield minimal information with respect to the current context. This said, it is an open question whether this account can shed light on affective priming within other tasks (such as the LDT or pronunciation task) that do not involve response competition factors favoring affective priming.

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"

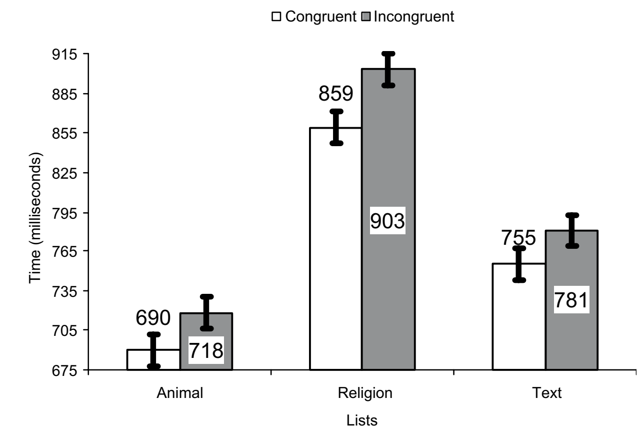

Figure 3 Mean latencies by affect congruence, Study 3.

(Murphy & Zajonc, 1993; Öhman & Soares, 1998). In addition, 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 threats (Öhman, Flykt, & Lundqvist, 2000).

Because affective associations may be more immediately accessible with pictures than with 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 and 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 (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 semantic category of the picture. 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.

In Study 4, we sought to conceptually replicate both Studies 1 (LDT) and 2 (evaluation) within the same design. Therefore, participants completed a lexical decision task and an evaluation task.

Method

PARTICIPANTS

Eighteen participants from the University of Illinois psychology subject pool participated for class credit.

APPARATUS AND STIMULI

Two Kodak Ektapro projectors fitted with Uniblitz high-speed shutters (less than 1-ms error) displayed the stimuli onto a 4- 4-foot white screen. One slide projector presented the primes, whereas the second presented the targets. Picture slides were approximately 3 3 feet. Letter strings, centered both vertically and horizontally within the picture, were composed of 6-in. white letters of medium thickness.

Prime slides were chosen from 80 unique picture slides: 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 connotation (puppy, rabbit, swan, and sparrow) and four of which were negative in 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 LDT blocks, the same prime and target stimuli were used. However, there were also eight nonword stimuli that were added as potential target stimuli.[1]

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 also were selected randomly, without replacement, from among the 8 (evaluate blocks) or 16 (LDT blocks) possible stimuli.

Participants were run individually. After arriving at the laboratory, the lights were turned off, followed by a 10-min 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 (e.g., not a word vs. a word or bad vs. good) that was placed on the screen during the trials. They were instructed to ignore the pictures and respond to the superimposed letter strings. A response box was used to record responses. Response options were always 1 and 4, which correspond to the outside keys of the box. However, response options (either word vs. not or bad vs. good) were randomly assigned to responses (1 vs. 4). For example, during certain blocks, the participants hit the 1 key to indicate that the target was bad; in other blocks, they hit the 4 for a bad target. The pictures and words were presented simultaneously and remained on the screen until a response was registered. There were approximately 6 sec between trials.

Results

The first five trials of each block were removed (as in the prior studies). Furthermore, reaction times that were 2 standard deviations below the mean (LDT = 370 ms; evaluation = 402 ms) or 2 standard deviations above the mean (LDT = 1,465 ms; evaluation = 1,220 ms) were replaced with these cutoff values. Error trials and nonword trials were excluded.

To assess the effects of category congruence and affective 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) 3 (congruence type) ANOVA. The analysis revealed a main effect for task (LDT = 740 ms; evaluation = 687 ms), $F(1, 17) = 7.22$, $p = .016$, as well as a main effect for congruence type, $F(2, 34) = 30.12$, $p < .000$. There was no interaction between these variables, $F(2, 34) = 1.58$, $p = .22$, indicating substantially the same results whether the task involved lexical decisions or evaluations. Means for the congruence type main effect are shown in Figure 4 (LDT) and Figure 5 (evaluation task).

To more precisely locate the source(s) of priming in the study, we next performed two further ANOVAs. In the first 2 (task) 2 (category congruence) ANOVA, we compared match identity to match affect latencies to determine whether participants implicitly encoded semantic information. Again, there was a main effect for task (LDT = 734 ms; evaluation = 671), $F(1, 17) = 9.1$, $p = .008$, as well as a main effect for category congruence, $F(1, 17) = 45.87$, $p < .000$, with no interaction, $F < 1$. Thus, participants implicitly encoded semantic information (e.g., whether the picture prime was a snake or a spider), a tendency that was not affected by the task (lexical decision vs. evaluation).

In the second 2 (task) 2 (affect congruence) ANOVA, we compared match affect latencies to mismatch both latencies to determine whether participants implicitly encoded affective information. A main effect for task was significant (LDT = 764 ms; evaluation = 713

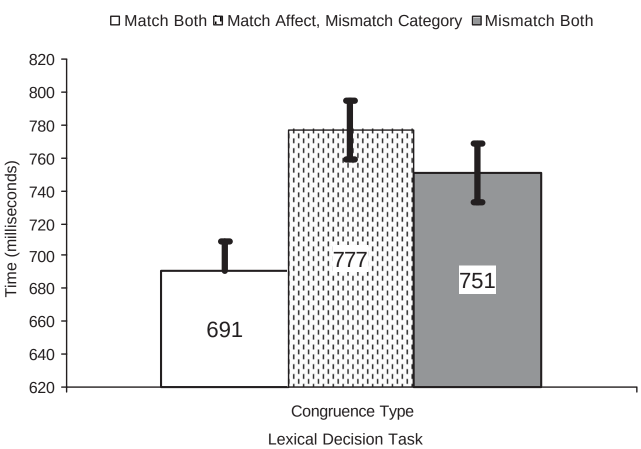

Figure 4 **Mean latencies for lexical decision task by congruence type, Study 4.**

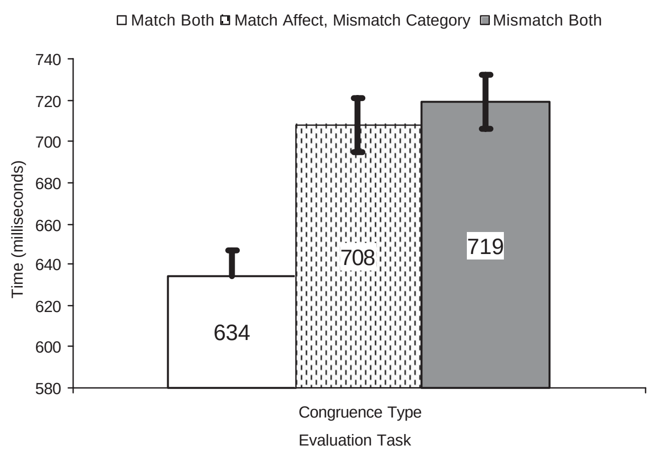

Figure 5 **Mean latencies for evaluation task by congruence type, Study 4.**

ms), $F(1, 17) = 6.55$, $p = .02$. There was no main effect for affect congruence, $F < 1$, and there was no Task Affect Congruence interaction, $F(1, 17) = 2.82$, $p = .11$. Thus, holding category constant, there was no affective priming at all, a result that replicates Studies 1 and 2.[2]

The accuracy rates were examined in a 2 (task) 3 (congruence type) ANOVA. No significant effects were found, ps > .15. The accuracy for the evaluation trials was 90%, suggesting participants were correctly distinguishing positive and negative words (without accuracy feedback).

Discussion

Study 4, within the context of one design, conceptually replicated both Studies 1 and 2 using picture primes. In the LDT, which removes response competition as a possible explanatory mechanism, we found category priming with no affective priming. In the evaluation task, which favors affective priming, we found the same results. 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; Storbeck & Robinson, 2003).

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 responses (Murphy & Zajonc, 1993; Öhman & Soares, 1998). Second, primes and targets were presented simultaneously, a factor that some have argued should lead to stronger affective priming relative to 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) versus slimy and unpleasant (snakes, spiders). Despite all of these procedural variations, the results conceptually replicated those of Studies 1 and 2, in this respect providing support for obligatory nature of semantic classifications.

STUDY 5

In Study 5, we returned to prime-target procedures of Studies 1 through 3, which had a 300-ms SOA. However, we used pictures rather than words as both primes and targets. As in Study 4, we focused on the factors of category congruence (match both vs. match affect) and affect congruence (match affect vs. mismatch both). In addition, we had participants complete two tasks. In one condition, they evaluated the target pictures. In another condition, they semantically categorized the target pictures.

Method

PARTICIPANTS

Forty-one participants from the University of Illinois psychology subject pool participated for class credit.

APPARATUS AND STIMULI

The apparatus was the same as in Study 4 except for a few modifications. A third, manual projector was used to display the task conditions onto the bottom half of the screen. For example, one of the task slides read “snake vs. rabbit” and a second read “good vs. bad.” The prime slides were the same as in Study 4 and the target slides were duplications of the prime slides and placed in a second projector.

PROCEDURE

All participants were run individually after undergoing dark adaptation. The study consisted of 12 blocks of

15 trials each. Half of the blocks concerned evaluation; the other half concerned categorization.

Blocks were constructed in the following manner. There were four target types 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 6 target-type pairings were crossed with the two tasks—categorization and evaluation—producing the 12 blocks of interest.

Prior to each block, the computer randomly selected one of the 12 blocks as well as response mappings for that block. Based on these randomized factors, the computer also informed the experimenter which judgment slide (e.g., bad vs. good) to display 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).

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 a 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.

The instructions and prime-target durations were the same as in Studies 1, 2, and 3. The target slide remained on the screen until a response was registered via the response box. There was a delay of approximately 6 sec between trials.

Results

Because there were only 15 trials per block, all correct responses were retained. Error trials were excluded. Latencies that were 2 standard deviations below (279.5) and 2 standard deviations above (1210.5) the overall mean were replaced with these values. 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. We note that parallel results emerge when these blocks are included in the analysis.

As in Study 4, there were three possibilities of interest—match both versus match affect versus mismatch both—depending on prime-target combination. This three-level congruence type variable was crossed with task (categorization vs. evaluation), resulting in six means per participant. A 2 (task) 3 (congruence type) ANOVA revealed a main effect for congruence type, $F(1, 40) = 17.03$, $p < .000$, but no main effect for task, $F < 1$, and no interaction, $F(2, 80) = 1.13$, $p = .33$. The main effect for congruence type is graphically displayed in Figure 6 (categorization) and Figure 7 (evaluation).

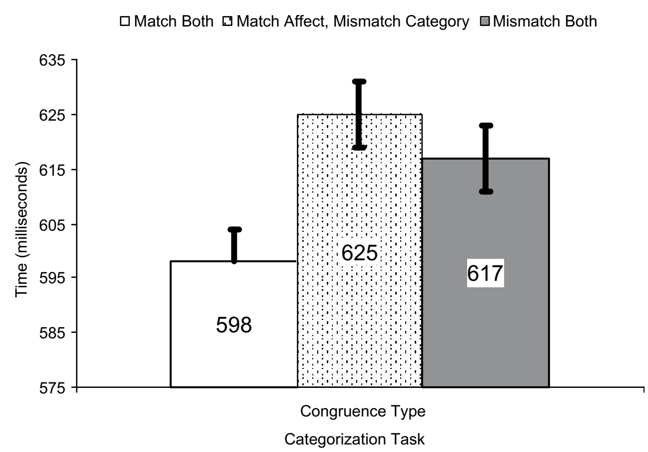

Figure 6 Mean latencies for categorization task by congruence type, Study 5.

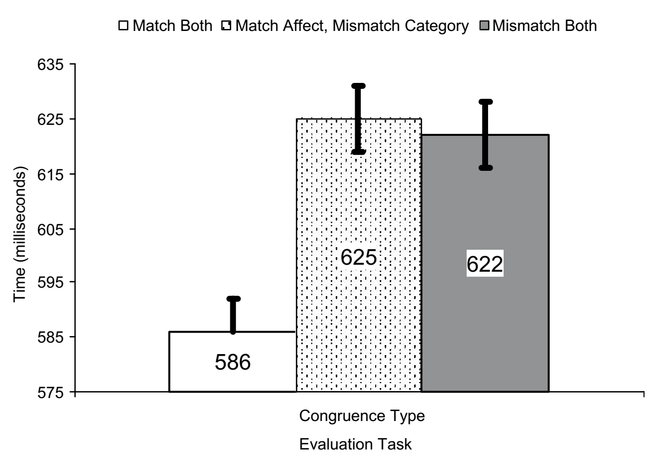

Figure 7 Mean latencies for evaluation task by congruence type, Study 5.

As in Study 4, we next performed two analyses to determine the locus of the congruence type main effect. We first contrasted match both versus match affect latencies in a 2 (task) 2 (category congruence) ANOVA. As expected, there was a main effect for category congruence, $F(1, 40) = 30.22$, $p < .000$, but no main effect for task, $F < 1$, and no Task Category Congruence interaction, $F < 1$. Thus, people extracted semantic information from the primes even though they were instructed to ignore them.

We next contrasted match affect versus mismatch both latencies in a 2 (task) 2 (affect congruence) ANOVA. Once again, there was no main effect for affect congruence, $F(1, 40) = 1.00$, $p = .32$. The task main effect,

$F < 1$, and Task Affect Congruence interaction, $F < 1$, also were not significant. Thus, we once again obtained no hint of affective priming.

We then analyzed the error rates in a 2 (task) 3 (congruence type) ANOVA. None of the effects were significant, $ps > .35$. It should be noted that accuracy rates were greater than 96% in all blocks; thus, the stimuli were clearly polarized in affective connotation.

Discussion

Study 5, similar to Study 4, included two tasks as a way of determining whether affective priming is moderated 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 LDT, this evidence was weak at best (see Note 2). 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 consistent in suggesting that the same information is extracted from prime stimuli regardless of one's processing goals.

GENERAL DISCUSSION

In our studies, we systematically compared semantic versus affective priming. Comparisons were made across three types of tasks (lexical decision, categorization, and evaluation) for two types of primes and targets (words and pictures). Two different SOAs (simultaneous or 300 ms) were used across the five 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 broad semantic distinctions were not present. Therefore, results from Studies 1 and 2 cannot be due to the stimulus materials. In total, the findings support the view that semantic analysis is more obligatory at encoding (see also Storbeck & Robinson, 2003).

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 (for a review, see Robinson, 1998). However, semantic meaning also can be elicited by subliminal stimuli (e.g., Dehaene et al., 2001). Thus, showing that affect can be elicited unconsciously is not sufficient for concluding that affect precedes semantic analysis at encoding (Lazarus, 1999).

There are at least three possible relations between cognition and affect at encoding. The first possibility is that affect may precede semantic analysis, which is consistent with LeDoux's (1996) model suggesting that there is a "quick and dirty" route to affective analysis. A second possibility is that semantic analysis precedes affective analysis, a position advanced by Storbeck & Robinson (2003). Finally, the third possibility is that semantic and affective analyses interact. For example, objects may be initially encoded as semantic/affective hybrids, such as "bad animals" on one hand and "good animals" on the other.

If the first possibility were likely, then we should have seen affective priming in our studies. Because we observed semantic, but not affective, priming in four studies, we suggest that this possibility is unlikely. If, instead, initial coding pertains to an interactive analysis of cognitive and affective features, then we should have seen interactions between category membership and affect. However, we never observed such interactions. If, finally, objects are initially encoded in terms of semantic relation but not affect, then we should (in many cases) obtain semantic priming without affective priming. Clearly, the data are consistent with this possibility.

These considerations suggest a particular relationship between semantic and affective aspects of encoding, one in which semantic features are preferentially encoded (Storbeck & Robinson, 2003). 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 LDT), 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, 2003), the comparative studies reported here were able to flesh this pattern out in more detail.

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 versus 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 (Perea & Rosa, 2002). 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.

In another study, Klauer and Musch (2002) also adopted a comparative approach to semantic and affective priming. Their results suggested that affective priming was related to two distinct mechanisms, one due to response competition and one due to an affective matching mechanism. Of note, however, their procedures were different than ours in several important ways. One, the studies used the "response deadline" procedure, whereby participants are asked to make responses faster than they otherwise might. Such procedures, as we have argued above, reduce spreading activation, which takes several hundreds of milliseconds to reach its peak. And two, Klauer and Musch did not orthogonally vary semantic and affective relations within a given study; rather, they examined these factors across studies. Given our Study 3 findings (in which semantic categories were held constant), we are not surprised that affective priming was more prominent in their studies than in ours.

In a final study worth mentioning here, De Houwer et al. (2002) had participants complete either a categorization task or an evaluation task. Their main finding was that priming was driven by the task demands. When the goal was to categorize the targets, semantic priming occurred; when the goal was to evaluate the targets, affective priming occurred. Such results are somewhat inconsistent with ours in that we always observed semantic priming and only observed affective priming under specific task conditions (e.g., Study 3). Two differences may account for the apparent discrepancy. First, De Houwer et al. did not systematically cross semantic and affective relations in their study. Rather, primes were always nonspecifically good or bad. As Study 3 of the present investigation suggests, such procedures might be more likely to lead to affective priming. Second, one generally expects stronger semantic priming when both prime and target are strongly associated with a semantic category (e.g., animals: dog-horse). The stimuli used by De Houwer et al. may have been too weakly associated to support semantic priming via spreading activation (Cree, McRae, & McNorgan, 1999; Neely, 1991).

The Priority of Semantic Analysis

Several behavioral studies are in agreement with our basic conclusions. In a couple of papers, for example, De Houwer and Hermans (1994; De Houwer, Hermans, & Eelen, 1998) have found identity priming, but not affective priming, within the pronunciation task. In these same papers, however, they obtained both identity and affective priming within an evaluation task. In another relevant study, Kemp-Wheeler and Hill (1992) found semantic, but not affective, priming in a pronunciation task. In the same papers, however, they also found both semantic and affective priming in the LDT. 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 may be parasitic, or dependent on, semantic meaning.

Moving to the literature on priming and social judgment, Erdley and D'Agostino (1988) were interested in the question of whether subliminal priming produces judgments that are construct specific or more broadly evaluative. To investigate this comparative question, they primed concepts such as 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.

In a recent article, we (Storbeck & Robinson, 2003) performed a more extensive review of related literatures. Briefly, we concluded that the data were consistent with the idea that semantic distinctions have to be made before affective associations can be retrieved. In this connection, we argued that the inferior temporal (IT) cortex is critical for producing a unique, invariant neural code for each object. Without this neural code, we argued that evaluations could not occur. In sum, these neural data suggest that semantic associations to the stimulus, completed within the higher areas of the visual cortex, are required before the amygdala has sufficient information for evaluation.

Furthermore, a recent study has shown that the human homologue of area IT (area LOC) seems to distinguish among objects that cannot be consciously recognized (Goebel, Muckli, Zanella, Singer, & Stoerig, 2001; see also Tovee, 1998). Relatedly, electrophysiological studies establish that object identification may occur within 100 ms of stimulus exposure (Rolls & Tovee, 1994). Although area IT (in humans, area LOC) is involved in object 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, Ono, & Nakamura, 1987).

In one particularly interesting test of the dependence of affect on prior semantic analysis, Fukuda et al. (1987)

cooled area IT but left the amygdala intact. Consistent with the idea that the amygdala is dependent on area IT (which is involved in identifying objects), neurons within the amygdala were less able to distinguish rewarding (food) from nonrewarding stimuli after area IT had been cooled. These data are rather dramatic in suggesting that affective analysis is typically dependent, or parasitic, on some prior semantic analysis. In sum, we argue that people cannot determine how they feel about an object until they know what it is (Clore & Ketelaar, 1997). This knowledge need not be conscious, however, as processing within area IT (in humans, area LOC) is very unlikely to have a conscious correlate.

In the context of some of the neural evidence discussed here, we must admit that our priming results are relatively indirect evidence for the primacy of semantic aspects of encoding. That said, they are nevertheless consistent with semantic primacy (see Storbeck & Robinson, 2003, for additional considerations).

Conclusions

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 prime-target relations, we found robust evidence for semantic priming with very little affective priming. In addition, Study 3 suggests that affective priming may be more likely when semantic variations are minimal. Both sets of findings point to the idea that encoding objects with respect to semantic category may be the more obligatory operation.

APPENDIX
Word Stimuli for Studies 1, 2, and 3

	Category		
Valence	*Religion*	*Animal*	*Texture*
Positive	angel	butterfly	creamy
	blessing	dove	delicate
	deity	duck	fluffy
	heaven	giraffe	gentle
	holy	kitten	satin
	nirvana	panda	silky
	pious	pony	smooth
	purity	puppy	soft
	sacred	rabbit	supple
	saintly	swan	velvet
Negative	devil	leech	abrasive
	evil	rat	bumpy
	hell	raven	coarse
	pitchfork	shark	grainy
	purgatory	skunk	harsh
	satan	snake	sharp

APPENDIX (continued)

	Category		
Valence	*Religion*	*Animal*	*Texture*
	sins	spider	jagged
	torture	squid	rocky
	vice	vulture	scratchy
	underworld	worm	tough

NOTE: Nonwords (Study 1) were created by taking the word stimuli and changing 1 to 2 letters.

NOTES

1. Our categories were broader in Studies 1 and 2 than in Studies 4 and 5 (e.g., dogs vs. snakes). We used narrower categories in Studies 4 and 5 because of the use of pictures 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. Even though the Task Congruence Type interaction was not significant, we still tested whether affective priming occurred in the evaluation task. We found a main effect for category congruence, $F(1, 16) = 19.93$, $p < .000$, and a main effect for affective congruence, $F(1, 16) = 5.25$, $p < .05$. Thus, the Study 4 data provide some hint that affective priming is stronger in the evaluation task. However, given the lack of a Task Congruence Type interaction, we are reluctant to make much of this finding, particularly because it was not conceptually replicated in Study 5.

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