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The Influence of Nonremembered Affective Associations on Preference

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An important influence on our preference toward a specific object is its associations with affective information. Here, the authors concentrate on the role of memory on shaping such preferences. Specifically, the authors used a multistage behavioral paradigm that fostered associations between neutral shapes and affective images. Participants that explicitly remembered these affective associations preferred neutral shapes associated with positive images. Counterintuitively, participants who could not explicitly remember the associations preferred neutral shapes that were associated with negative images. Generally, the difference in preference between participants who could and could not remember the affective associations demonstrates a critical link between memory and preference formation. The authors propose that the preference for negatively associated items is a manifestation of a mechanism that produces an inherent incentive for rapidly assessing potentially threatening aspects in the environment.

Keywords: preference, affective priming, emotion, memory, awareness

Preference for one choice over another is a key determinant in making many everyday decisions. Therefore, learning how such preferences for items in our environment develop is important for understanding how people make decisions that guide behavior. One important source of information in preference formation is the association between a target item and familiar, preferred or nonpreferred, stimuli. For example, pairing the presentation of a neutral image with a positive image can increase liking for the neutral image (Murphy & Zajonc, 1993). More generally, affective priming studies have repeatedly shown that emotional pictures can modify people's attitude toward an associated object, even if they are unaware of the emotional primes (Bargh & Ferguson, 2000; De Houwer, Hendrickx, & Baeyens, 1997; Hermans, Van den Broeck, & Eelen, 1998; Murphy & Zajonc, 1993; Rotteveel, de Groot, Geutskens, & Phaf, 2001). Similar demonstrations have also been reported by researchers studying issues in marketing, learning theory, and social psychology, who looked at how associations can modify everything from preference for brand names to racial bias (Allen & Janiszewski, 1989; Banse, 2001; Katz & Zalk, 1978; Levey & Martin, 1975). In addition, conditioning studies have shown that prior associations of a neutral object with pleasant or aversive stimuli can even affect a person's physical, somatic reaction (as measured by skin conductance response, heart rate, and so on) to that object (Bechara, Tranel, Damasio, Adolphs, Rockland, & Damasio, 1995; Ohman, Hamm, & Hugdahl, 2000). Such reports indicate that associations of which we are not aware, either because we lack perceptual awareness for the affective stimulus (Fulcher & Hammerl, 2001) or because we do not realize that there is an association between the affective and neutral stimuli (Glaser & Banaji, 1999; Olson & Fazio, 2001; Staats & Staats, 1958), can nevertheless guide conscious behavior. Although some doubt has been expressed about whether implicit preference formation is possible (Field, 2000, 2001), a consensus is building that implicit processes are crucial for preference formation (Fulcher & Hammerl, 2001; Olson & Fazio, 2001), opening up the way to studying the underlying mechanisms.

Studies of the influence of awareness of affective stimuli on judgment can be divided into two categories depending on the type of awareness that is being measured or manipulated. In the first category of studies, experiments manipulate perceptual awareness of the affective prime stimulus itself to examine implicit preference modulation (De Houwer, Hendrickx, & Baeyens, 1997; Hermans, De Houwer, & Eelen, 2001; Murphy & Zajonc, 1993; Wong & Root, 2003). In these experiments, participants are unable to perceive the affective stimulus because it is presented for a brief duration, the image is degraded, and/or the emotional stimulus is masked by a scrambled image presented before or after it. For example, participants are shown an affective stimulus (e.g., a smiling or frowning face) under conditions favoring either implicit perception or explicit perception followed by a neutral target object (e.g., a Chinese ideograph for participants who do not read Chinese). Participants are then asked to rate how much they like this target object. Although participants are unable to perceive the affective stimulus consciously, it nevertheless influences how they react to the neutral target object. This approach has been fruitful for exploring implicit and explicit preference modulation, but a potential drawback is that participants often know they are going to be asked to evaluate the targets before the stimulus pair are presented and can thereby adjust their response based on their predictions of what the experiment entails (sometimes referred to

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as a demand artifact). For example, if, in an explicit perception trial, you see a smiling face before a Chinese ideograph, and you know that the experimenters are going to ask about your preference for this ideograph, your feelings for the target ideograph may be changed by your predictions of why the smiling face was presented. Once a strategy has been established, participants' behavior may be altered even when they cannot consciously perceive the priming stimulus in subsequent trials (Kunde, Kiesel, & Hoffmann, 2003).

In the second category of studies, participants generally are perceptually aware of the affective stimulus, but they are unaware of its influence on their behavior (Glaser & Banaji, 1999; Mitchell, Anderson, & Lovibond, 2003; Olson & Fazio, 2001). Specifically, instead of masking the existence of the affective stimulus, the fact that the affective primes consistently appear with the neutral targets remains obscured from the participants (e.g., because they are performing a distracter task) (Baeyens, Hermans, & Eelen, 1993; Glaser & Banaji, 1999; Lombardi, Higgins, & Bargh, 1987; Martin, Seta, & Crelia, 1990; Schwarz & Clore, 1983). This type of awareness of the relation between the affective primes and the neutral targets is sometimes called "contingency awareness." Because participants are unlikely to change their attitude toward the neutral targets consciously if they are unaware of the association between the affective primes and the neutral targets, manipulating contingency awareness instead of perceptual awareness can provide a possible solution for the aforementioned strategy bias as a result of demand artifacts. However, possible methodological concerns still exist in this type of studies. For example, a common source of possible strategy bias remains when the preference measure is administrated immediately after the prime–target pair is presented (Glaser & Banaji, 1999; Martin, Seta, & Crelia, 1990).

The study of awareness in the context of affective associations goes beyond strategic biases or methodological issues, however. A critical question is whether similar or separable cognitive mechanisms underlie preference formation when we are aware and when we are unaware of the source of potential influence on our judgments. One possibility is that there is no hard boundary between explicit (i.e., aware) and implicit (i.e., unaware) processing; and the distinction is merely a matter of awareness level (Bar, Tootell, Schacter, Greve, Fischl, Mendola, et al., 2001; Greenwald, 1992; Ohman, Dimberg, & Esteves, 1989). Under some conditions, however, behavior can be dramatically different depending on awareness (Banse, 2001; Bargh & Ferguson, 2000; Glaser & Banaji, 1999; Lombardi, Higgins, & Bargh, 1987; Martin, Seta, & Crelia, 1990; Merikle & Reingold, 1990). On one hand, it has been shown that if participants are unaware of an influencing stimulus or the association between the affective stimulus and the neutral target, they tend to react in accordance with the attributes of that influence (e.g., they tend to like otherwise neutral objects associated with positive stimuli). This effect is termed the *assimilation effect* because, in its behavioral manifestation, the neutral target assimilates the properties of the prime. On the other hand, when participants are aware of the influence of the primes, they behave in opposition to its valance (e.g., they tend to dislike objects associated with positive stimuli). This effect is termed the *contrast effect* because the neutral target assumes properties that contrast those of the prime. These significant qualitative differences between the assimilation and contrast effects suggest that distinctly different cognitive mechanisms underlie implicit and explicit preference formation.

Is awareness the only factor that dictates our susceptibility to affective influences in our preference toward an otherwise neutral object? We have fine-tuned this question by focusing on the role of memory on these effects. Specifically, can subsequent memory of a previously presented prime–target association influence our judgment independent of whether we were aware of the association at the time of presentation?

To address this question, the present study manipulated both memory and perceptual awareness for the priming events. Subsequent memory is tightly connected to awareness at the time of presentation in that it is virtually impossible to remember explicitly an event of which we were unaware. Therefore, the primes in this experiment were presented for either brief or much longer durations. Critically, we wanted to examine the influence of an affective association when participants were aware of the prime presented but later could not remember the affective association between the prime and the target.

The experimental paradigm included four separate stages. First, associations between neutral shapes and affective primes were created by preceding and following each neutral shape with affective primes, which were either presented briefly (reduced perceptual awareness) or for a considerably longer duration (increased perceptual awareness). We used a variety of different stimuli as affective primes that invoked a range of emotional reactions (e.g., sad, threat, neutral, cute). These stimuli were chosen to be both particularly strong in emotional content (Lang, Bradley, & Cuthbert, 2001) and easily recognizable. A relatively large number of associations were incorporated to increase the likelihood that a sufficient proportion of the associations would later not be explicitly remembered. Second, after the priming procedure, a two-alternative forced-choice (2AFC) preference task was administered, in which participants were asked which of the previously primed shapes they preferred. To control for expectations, participants were not told about this subsequent preference task until after the priming procedure. Participants were prompted to respond as quickly as possible to measure their immediate reactions toward the shapes. Third, after measuring their preferences for the primed shapes, we tested recognition memory by asking subjects to report what type of affective prime was previously associated with each neutral shape. This allowed us to divide the participants based on how well they remembered the affective associations. Finally, an awareness test was used to determine to what extent the briefly presented primes from the first phase of the experiment could be consciously perceived by each individual participant.

Methods

Participants

Participants were 40 individuals (23 females; mean age = 22.1 years, standard deviation [*SD*] = 5.24 years; mean education = 15.3 years, *SD* = 2.2 years) with no history of psychiatric or neurologic disorders. All participants gave written informed consent to protocols approved by the Partners Human Research Committee (2002P-001339).

Materials

Scenes, objects, animals, and faces with positive, negative, and neutral valence were selected as affective primes. A total of 72 affective primes were used; 29 of the images were chosen from The International Affective Picture System (IAPS) (Lang, Bradley, & Cuthbert, 2001) and 43 of the images were chosen from the Internet. Images from the Internet contained similar content as those from the IAPS collection. Stimuli included both color and black and white images, and they were presented on a black background throughout the experiment. Positive images consisted of cute subjects (e.g., smiling babies and cute animals) and desirable objects (e.g., money, food, and cars). Negative images consisted of sad pictures (e.g., images of abuse and grief) and threatening images (e.g., guns and snakes). Neutral images consisted of a mix of scenes of everyday life (e.g., a street scene), pictures of mundane objects (e.g., a picture of a filing cabinet), and unusual, but affectively neutral, objects and scenes (e.g., an interestingly captured close-up of a leaf). We used a variety of different stimuli that invoked a range of emotions as affective primes for increased ecologic validity. Equal numbers of each affective image category were used in the experiment. Meaningless patterns were used as target stimuli, and patterns with colorful scribbles were used as masking stimuli (see Figure 1 for examples of stimuli). Images not taken from IAPS were rated on the same 1 (strongly negative) to 9 (strongly positive) rating scale as IAPS for (direct compatibility) by a separate group of 13 participants. The average rating for negative images was 2.29 (SD = .47), for positive images 7.40 (SD = .55), and for neutral images 5.01 (SD = .31).

Stimuli were presented on a 21-inch color monitor connected to a Power Macintosh G4 computer. The monitor was set to a screen resolution of 1024 × 768 pixels, and images were 200 × 200 pixels in size and presented on a black background. Participants were seated approximately

Figure 1. Examples of affective prime stimuli and target shapes.

70 cm from the screen. The experiment was programmed in Matlab using the Psychophysics Toolbox (Brainard, 1997; Pelli & Zhang, 1991) extensions. Furthermore, the experimenter always sat with participants to help ensure compliance with experimental instructions.

Procedure

Overview. The experimental procedure comprised four parts. Each participant started with the *priming procedure* in which the associations between meaningless target shapes and affective primes were established with masked primes presented either for 33 ms (brief exposure condition) or 450 ms (long exposure condition) and meaningless target shapes presented for 600 ms. Participants then took part in a *2AFC preference task* to determine what influence these associations had on participants' preferences for the meaningless target shapes. After this, a *memory test* was given to determine whether participants could explicitly remember the associations between the neutral shapes and the valence of the affective primes presented in the priming procedure. Finally, an *awareness assessment* was undertaken to determine whether participants could have been aware of the briefly presented primes. We now elaborate on each of these stages.

Priming procedure. Each trial consisted of a short sequence of rapidly and consecutively presented images. Participants were informed that they would see a sequence of meaningless (target) shapes and colorful scribbles (masks), and, in some of the trials, meaningful images would appear within the sequence as well. Participants were informed that meaningful images would not necessarily appear in all trials to account for any lack of perceptual awareness of briefly presented emotional stimuli and to minimize bias. They were instructed to attend to each image because they would be given a subsequent memory test. Participants were informed that there would be four priming runs to help their memorization (each run consisted of 18 trials). At this stage of the experiment, no mention was made of the brief exposure, presumably subliminal, condition, the exact nature of the ensuing memory test, or the existence of the subsequent preference test.

The order of presentation on each trial was: a colorful mask, an affective prime, a target shape, second affective prime, a second mask, a third affective prime, a second target shape, a fourth affective prime, and a third mask (see Figure 2). On each trial, the two target shapes presented were always different. The four affective primes were also always different but always with the same affective valence and presented for the same duration (e.g., four different negative images). Therefore, both of the targets on each trial were primed with the same affective valence and with primes of the same duration. Each trial contained four affective primes to increase the affective strength of the primes. The target shapes and masks were all presented for 600 ms. The affective primes were presented for 33 ms in brief-duration trials and for 450 ms in long-duration trials (see Figure 2). Half of the trials were brief-duration trials and half were long-duration trials. Between trials, there was a 2000-ms blank screen. A total of 36 meaningless shapes were primed in this fashion by a total of 72 affective primes. Priming runs consisted of 18 such priming trials and each of the shapes was presented only once in each run. Furthermore, each affective prime was presented only once in each run and never with the same

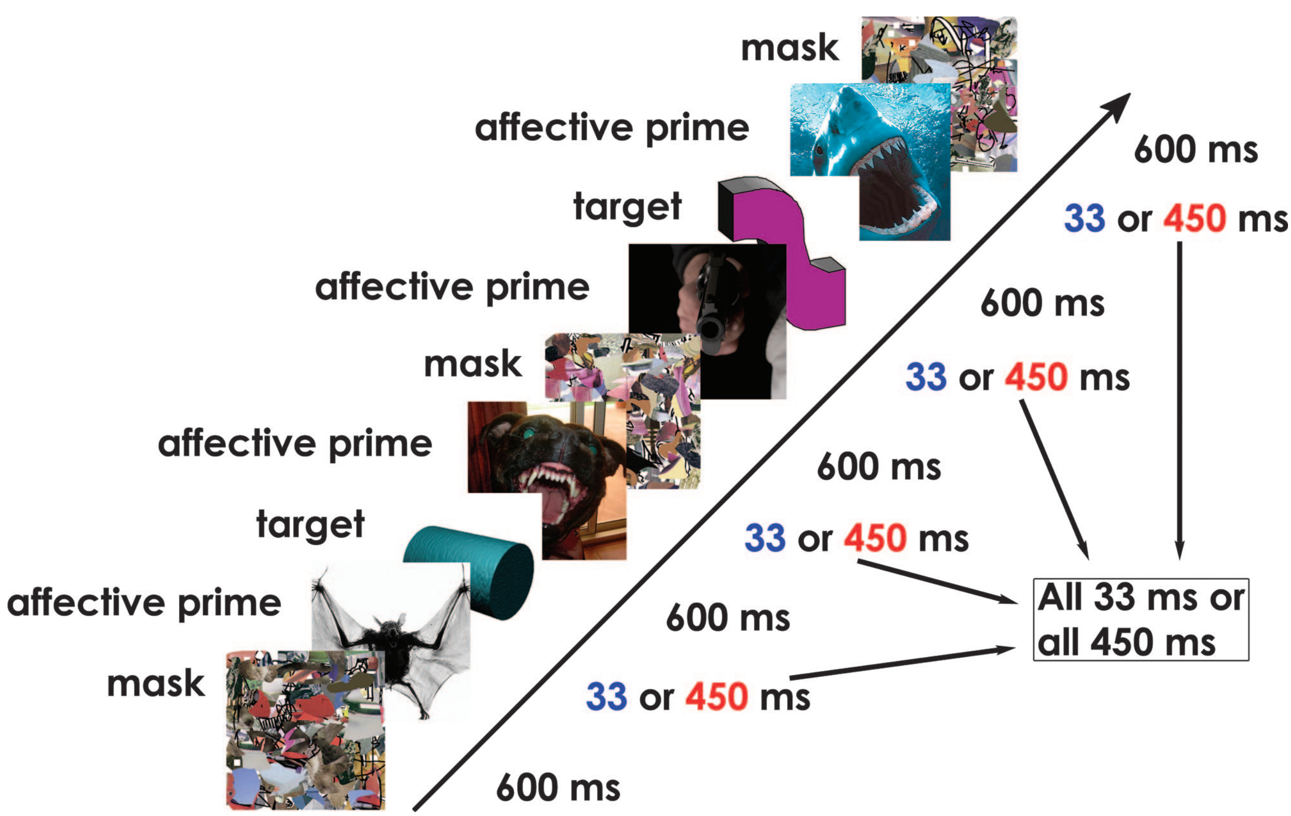

Figure 2. A single trial sequence in the priming procedure. Each trial was comprised of a rapid, serial visual presentation sequence. Trials began with a colorful mask followed by a series of affective primes, meaningless shape targets, and other masks. All four affective primes were the same valence and were presented for the same duration either all for 33 ms in the brief presentation condition or all for 450 ms in the long presentation condition.

meaningless target shape between runs. Each run contained three of each of the six types of trials: brief presentation positive, brief duration neutral, brief duration negative, long duration positive, long duration neutral, and long duration negative. Four such priming runs were presented, and the order of trials was randomly shuffled from run to run to reduce any chance of bias. Furthermore, for each participant, shapes were randomly associated with different valence primes and the order of trials was random.

2AFC preference task. The 2AFC preference task began only after all of the priming runs were completed. Participants were told that they would see a pair of meaningless shapes side by side and were asked to indicate which of the two shapes they liked better. The pairs of shapes consisted of one shape that was previously primed with either positive or negative stimuli and the other shape was either primed with opposite valence or neutral valence images. Shapes were chosen such that both shapes had previously been presented either in the brief or long exposure condition during the priming procedure. Thus, there were six trial types in the 2AFC preference task that corresponded to how the pairs of shapes were primed. Specifically, the trial types were: positively primed shapes paired with neutrally primed shapes, negatively primed shapes paired with neutrally primed shapes, and positively primed shapes paired with negatively primed shapes. Each of these three trial types occurred for brief and longer presentation duration primes to produce the six trial types. Each of the 36 shapes from the priming task was presented four times resulting in a total of 72 preference trials for each participant. The order in which the pairs appeared was random. Participants were asked to respond as quickly as possible.

The preference task began with a short practice block with novel shapes to familiarize participants with the task. Once the practice block was completed, the experimental block began using the aforementioned meaningless shapes from the priming procedure. Each trial consisted of the presentation of a pair of shapes for 650 ms followed by a pair of masks for 350 ms. Masks were used to control exposure duration of the shapes and to control for afterimage. This helped ensure that participants used their first impression to report their preference.

Memory test. After the preference task, participants were given a recognition memory test. They were shown each of the 36 shapes that they saw during the priming procedure and were asked whether they remembered the shapes as being associated with positive, neutral, negative, or no images (to allow responses also for the shapes that were originally presented briefly, in which participants could have lacked perceptual awareness) during the priming procedure. The shapes were presented in the center of the screen with the four possible response options with their respective response keys listed below them. They were given 2000 ms to respond and were instructed to respond as accurately as possible within the time allotted. The experimenter made sure that the participants all understood the directions and would be able to respond appropriately. The order of the 36 trials was random.

Awareness assessment. For the awareness assessment, participants were shown sequences of images in exactly the same manner as shown for the brief exposure condition in the priming procedure (i.e., mask, affective prime [33 ms], shape, affective prime, mask, affective prime, shape, affective prime, and mask). The affective stimuli and masks were the same as those used in the priming procedure, but the shapes used were novel. Participants were asked to answer three questions. First, identify the valence of the briefly presented affective primes (3AFC: positive, negative, or neutral). Second, recognize which shape out of four alternatives had just been presented. Finally, determine which out of four affective images they saw. It was emphasized to participants that they were to make their decisions based only on what appeared in the trials from this phase of the experiment and not what had occurred in previous stages of the experiment. To obtain the most conservative measure of awareness, these tasks were not timed and participants were instructed to be as accurate as possible. In addition, that we used here the actual affective images from the priming stage increased the likelihood of conscious perception and thus increased the conservativeness of our measurement. There were a total of 12 awareness trials per participant. Participants were exposed to an equal number of awareness trials with positive, negative, and neutral images. The order of trials, shapes, and primes were randomized for each participant.

Analysis

Because of the categorical and univariate nature of the data from the 2AFC preference test and memory test, a chi-squared (χ^2) test was used for most statistical comparisons. At first, χ^2 was stratified across participants, although it was found that significance values did not change substantially if the statistic was not stratified, so unstratified χ^2 are reported here for simplicity. Except where noted, all p values are reported relative to random chance performance (50% in the 2AFC preference test, 33% in the 3AFC awareness test, and 25% in the 4AFC memory test). The χ^2 test allowed us to determine if there was a significant preference bias for either positively or negatively primed shapes. This test also allowed us to determine if participants correctly identified the affective association in the memory test more often than would be predicted if they were randomly guessing. The only exception to using the χ^2 test was for comparing reaction times, in which a t test was used.

Results

When averaging across all participants, no preference bias was seen for positively, neutrally, or negatively primed shapes for either the brief or longer exposure conditions (Figure 3a). Because we were interested in the effects of memory of a priming event on preference, we used participants' memory results to compare implicit and explicit preference formation. Therefore, using performance in the memory test as the critical dimension, we divided the entire group of participants into two subgroups: high memory ($n = 16$; 45.6% correct responses on the memory test [chance = 25%]; $\chi^2 = 45.56$, $p < .001$) and low memory ($n = 24$; 23.1% correct responses; $\chi^2 = 1.89$, $p > .05$). These groups were divided by using mean percentage of correct answers (34.4%) as the cutoff point for the high and low memory groups. The average reaction time for response for the memory test for the low memory group was 1110 ms ($SD = 149$ ms) and for the high memory group was 1102 ($SD = 163$ ms). Note that the titles "high memory" and "low memory" are used purely to describe participants' performance on the memory test in the present experiment. No judgment about the type of memory involved or participants' inherent abilities is implied by these monikers. The memory results used for this assignment into subgroups were for the long-exposure condition; no group showed memory performance above chance for shapes in the brief-exposure condition. We removed the shapes for which the low-memory group correctly identified the valence of the primes associated with them and removed the shapes for which the high-memory group incorrectly identified the valence of their priming images. By doing this, we eliminated from the analysis shapes that high-memory participants did not remember and shapes that low-memory participants did remember. This was done to make it more likely that we were comparing shapes for which the affective association was remembered with shapes for which the affective association was not remembered.

This critical analysis indicated that high-memory participants liked positively primed shapes and disliked negatively primed shapes, regardless of presentation duration. Specifically, for shapes that were in the brief presentation condition, high-memory participants preferred positively primed shapes 61.0% of the time when

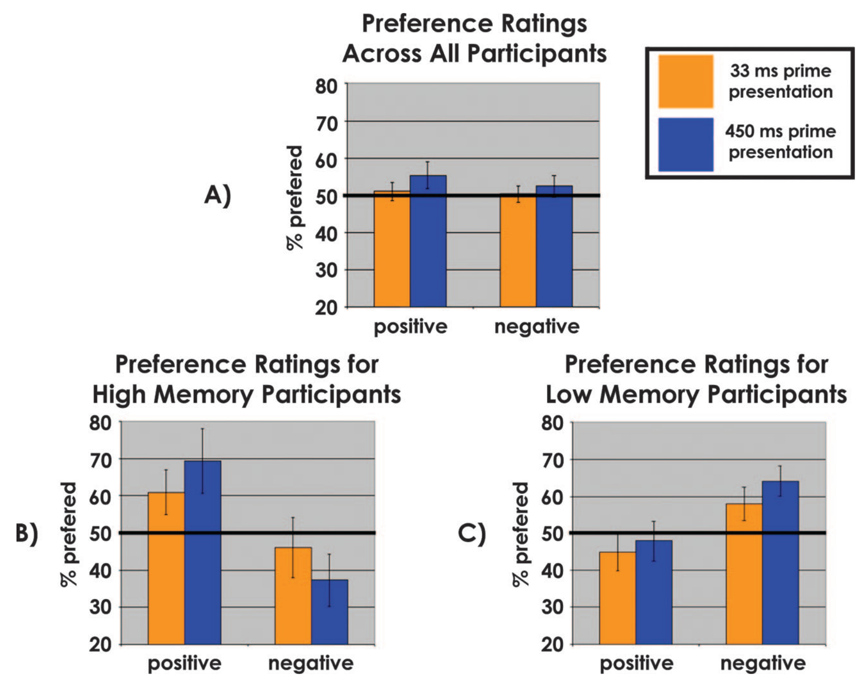

Figure 3. 2AFC preference for positively and negatively primed shapes when the other shape was neutrally primed. (a) Results aggregated across all participants and trials shows no preference bias. (b) Results for remembered trials in high-memory participants. These participants prefer shapes primed with positive images and dislike shapes primed with negative images. (c) Results for nonremembered trials in low-memory participants showing their significant preference for negatively primes shapes.

they were paired with neutrally primed shapes, negatively primed shapes 46.2% of the time when paired with neutrally primed shapes (Figure 3b), and positively primed shapes 63.9% of the time compared when paired with negatively primed shapes. For the long presentation condition, high-memory participants preferred positively primed shapes 69.5% of the time when paired with neutrally primed shapes, negatively primed shapes 37.3% of the time when paired with neutrally primed shapes (Figure 3b), and positively primed shapes 71.6% of the time when paired with negatively primed shapes (see Table 1 for χ^2 and p values). With regard to individual results, 12 of 16 participants preferred positively primed shapes when they were paired with neutrally primed shapes (additionally, three participants were at 50% preference),

Table 1
Preference Results As a Factor of How the Shape Was Primed

	High memory		Low memory	
	% preferred	χ^2	% preferred	χ^2
Brief presentation				
Neg over neut	46.2%	0.31	57.9%	3.85*
Pos over neut	61.0%	1.98	44.9%	1.73
Pos over neg	63.9%	7.52**	26.7%	19.60***
Long presentation				
Neg over neut	37.3%	4.32*	64.2%	13.88***
Pos over neut	69.5%	14.41***	47.9%	0.29
Pos over neg	71.6%	23.10***	27.4%	23.02***

* $p < .05$. ** $p < .01$. *** $p < .001$.

10 of 16 participants preferred neutrally primed shapes when they were paired with negatively primed shapes (additionally, three participants were at 50% preference), and 13 of 16 participants preferred positively primed shapes when they were paired with negatively primed shapes (additionally, two participants were at 50% preference). As mentioned previously, these data are only for shapes for which high-memory participants correctly identified the valence of their corresponding priming images. For the shapes that these participants incorrectly identified the valence of their priming images, no preference bias was observed (no significant deviation from 50% preference). This result is what we would predict because these shapes likely consisted of a mix of targets for which high-memory participants were not able to recall the affective association and those for which high-memory participants forgot or mistakenly misidentified between the preference task and memory test.

Critically, low-memory participants preferred negatively primed shapes. Specifically, for shapes in the brief-presentation condition, participants preferred negatively primed shapes 57.91% of the time when paired with neutrally primed shapes, positively primed shapes 44.91% of the time when paired with neutrally primed shapes (Figure 3c), and positively primed shapes 26.7% of the time when paired with negatively primed shapes. For the long-presentation condition, low-memory participants preferred positively primed shapes 47.9% of the time when paired with neutrally primed shapes, negatively primed shapes 64.2% of the time when paired with neutrally primed shapes (Figure 3c), and positively primed shapes 27.4% of the time when paired with negatively primed shapes. See Table 1 for a summary of these results along with corresponding χ^2 and *p* values. With regard to individual results, nine of 24 participants preferred positively primed shapes when they were paired with neutrally primed shapes (additionally, five participants were at 50% preference), 15 of 24 participants preferred negatively primed shapes when they were paired with neutrally primed shapes (additionally, five participants were at 50% preference), and 20 of 24 participants preferred negatively primed shapes when they were paired with positively primed shapes (additionally, no participants were at 50% preference). These results cannot be explained by low-memory participants incorrectly misclassifying the negatively primed shapes as being associated with positive prime because they were equally likely to report these shapes as being primed with positive or neutral images in the memory test. For the shapes that these participants correctly identified the valence of their priming images, no preference bias was seen for any of the shapes (no significant deviation from 50% preference). This result is what we would predict because these shapes consisted of a mix of targets for which low-memory participants were able to recall the affective association and those for which low-memory participants responded correctly during the memory test by chance.

Additionally, the low-memory and high-memory participants differed in the amount of time taken to report their preferences. The average reaction time for high-memory participants on the preference task was 672 ms ($SD = 145$ ms), and for low-memory participants, reaction time was 583 ms ($SD = 116$ ms) ($t[38] = -2.15$, $p < .05$). There was no significant difference in reaction time between the groups for the memory test.

In summary, low-memory participants tended to prefer negatively primed shapes and to take less time to make their choice. In contrast, high-memory participants tended to choose positively primed shapes in the 2AFC preference task and take more time to report this preference.

A 3AFC awareness test was administered after the experimental procedure. Participants were correctly able to identify the valence of briefly presented images 47.9% of the time (chance = 33%; $\chi^2 = 36.75$, $p < .001$) and correctly recognize the identity of these pictures 58.1% of the time (chance = 50%; $\chi^2 = 10.01$, $p < .01$). Thus, although the brief presentation duration did not completely prevent perceptual awareness of the prime, it can be considered a reduced awareness condition. Importantly, based on their performance on the awareness test, no significant differences in preference bias or memory performance were found between low and high perceptual awareness participants.

Discussion

The present study was designed to examine explicit and implicit preference formation by comparing preference for shapes when their association with an affective prime could be remembered and when it could not be remembered. Our results demonstrate a link between memory for an affective association and preference, as indicated by the significant qualitative differences in preference bias between high- and low-memory participants. Specifically, high-memory participants preferred positively primed shapes, whereas low-memory participants preferred negatively primed shapes.

Interestingly, this pattern of results was seen for both conditions: when the primes were presented for a long duration and subjects were aware of their content, and when the primes were presented very rapidly and awareness was reduced. This is surprising because one might predict that high-memory participants would perform like low-memory participants when perceptual awareness is reduced, if awareness level was what determined the memory-related preference biases. The simplest explanation for these results might be that high-memory participants reported liking shapes they subjectively remembered as being associated with positive images, and they reported not liking shapes they subjectively remembered as being associated with negative images, regardless of the accuracy of their memory. However, this explanation does not perfectly fit the data because high-memory participants only liked shapes they correctly identified as being associated with positive images and did not like shapes they correctly identified as being associated with negative images. In other words, high-memory participants did not prefer shapes that they misidentified as being associated with positive images when they were actually associated with neutral or negative images.

For the purpose of this discussion, one can consider high memory as reflecting contingency awareness of the previously presented affective association. Low memory is then comparable to a lack of contingency awareness because the subjects in this condition were not consciously aware of the original affective association (although they still could have been aware at presentation but have forgotten it by the time their memory was gauged). Given these definitions, how would these results compare with the assimilation/contrast model? The pattern of these results is opposite of what would be expected; we observed assimilation effects in the aware (high-memory) participants rather than the unaware participants, and contrast effects in the unaware (low memory) participants rather than in the aware participants. The explanation for this apparent contradiction might be that in most previous demonstrations of assimilation/contrast effect, the preference judgments were typically reported immediately after the prime–target presentation. In the present experiment, however preference was reported significantly after the priming stage, and strategy effects resulting from demand artifacts, therefore, are likely to have played a significantly reduced role.

Perhaps the most important result we report here is that low-memory participants preferred shapes associated with negative affective primes. Although at this point one can only speculate on the exact explanation, we propose that this result is related to the observation that people's attention is drawn to negative images because of their importance to our survival, even when they are unaware of these negative images (Carretie, Hinojosa, Mercado, & Tapia, 2005; MacLeod & Hagan, 1992; van Honk, Tuiten, van den Hout, et al., 2000). Therefore, negatively primed shapes might have been attended to a greater extent than positively or neutrally primed shapes. Because low-memory participants were unaware of the reason that their attention was spontaneously drawn to the negatively primed shapes, they misattributed this attention-based reaction as preference for the specific shapes. Indeed, the prior attentional status of previously seen items has been shown to impact participants' subsequent emotional response to such items (Fenske, Raymond, Kessler, & Tipper, 2005; Raymond, Fenske, & Tavassoli, 2003). High-memory participants, on the other hand, were able to overcome this misattribution because they could remember the association between the shapes and the emotional primes and, therefore, knew the source of their attitude toward the shapes. This is reminiscent of an account of the assimilation/contrast and mere exposure effects, which postulates that we might consciously discount an unconscious misattribution (Bornstein & D'Agostino, 1994; Stapel, Koomen, & Zeelenberg, 1998; Wegener & Petty, 1995). Taken a step further, this attention-based response might relate to Biederman's (Vessel & Biederman, 2001) proposal that objects that are spontaneously chosen for viewing can directly cause positive affective reactions possibly through the same neurochemicals released in response to a rewarding stimulus. Thus, the negatively primed shapes might elicit an initial, attention-based, positive affective reaction because they are spontaneously chosen for viewing, although they had been associated with negative images.

This speculative proposal, that people are motivated by survival-based curiosity when confronted by negative stimuli, might help explain another counterintuitive result in the literature: That people sometimes have neural and behavioral responses to negative stimuli that are more typical of a response to positive stimuli. In particular, it has been shown that neural regions more associated with pleasure and liking are sometimes active also in response to negative stimuli, similar to the IAPS images used in the present study (Hamann, Ely, Grafton, & Kilts, 1999; Paradiso, Johnson, Andreasen, et al., 1999). We propose that this "positive" response is really a reflection of participants' initial survival-based motivation to rapidly assess the potential threat of the negative stimuli. In light of our account, it would make sense for an organism to have an incentive to allocate as much attention as possible to a stimulus that might pose a threat, and this incentive might be realized by initially providing the illusion of positive affect. Naturally, additional experiments will have to be conducted to test this hypothesis.

In conclusion, the primary goal of the present experiment was to study the effect of explicit memory of affective associations on preference formation. The different judgments seen between high- and low-memory participants demonstrate a critical link between memory and preference formation. Furthermore, these results might indicate that separable cognitive mechanisms mediate preference formation when we are aware, and remember, the sources of potential influence. Finally, we found that participants who did not explicitly remember the affective association surprisingly preferred negatively primed shapes, possibly illuminating a novel dimension in which survival-based consideration might guide our everyday behavior.

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