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Affect, Cognition, and Awareness: Affective Priming With Optimal and Suboptimal Stimulus Exposures

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The affective primacy hypothesis (R. B. Zajonc, 1980) asserts that positive and negative affective reactions can be evoked with minimal stimulus input and virtually no cognitive processing. The present work tested this hypothesis by comparing the effects of affective and cognitive priming under extremely brief (suboptimal) and longer (optimal) exposure durations. At suboptimal exposures only affective primes produced significant shifts in Ss' judgments of novel stimuli. These results suggest that when affect is elicited outside of conscious awareness, it is diffuse and nonspecific, and its origin and address are not accessible. Having minimal cognitive participation, such gross and nonspecific affective reactions can therefore be diffused or displaced onto unrelated stimuli. At optimal exposures this pattern of results was reversed such that only cognitive primes produced significant shifts in judgments. Together, these results support the affective primacy hypothesis.

The affective primacy hypothesis (Zajonc, 1980) holds that affective reactions can be elicited with minimal stimulus input. This hypothesis challenges the cognitive appraisal viewpoint (Lazarus, 1982), which maintains that affect cannot emerge without prior cognitive mediation. In this article, we provide evidence relevant to this debate and propose a theoretical model that describes how various stimuli can elicit an early affective reaction that may be sustained or diluted by subsequent cognitive operations.

Affective primacy was first suggested by a mere exposure experiment (Kunst-Wilson & Zajonc, 1980) in which subjects, by virtue of repeated exposures, developed affective preferences for previously novel Chinese ideographs. In that experiment the ideographs were first presented under degraded viewing conditions. Later, when given direct recognition memory tests, subjects could not distinguish these old stimuli from new stimuli they had never seen. Yet, despite this lack of overt recognition, when asked which of two ideographs, old or new, they liked better, subjects consistently preferred the previously presented stimulus. Moreover, response time for the liking judgment was found to be significantly less than that for the direct recognition judgment (see Seamon, Brody, & Kauff, 1983, for an extension of these data).

One way of interpreting these results is to allow for the possibility that gross affective discriminations can be made virtually without awareness, whereas cognitive discriminations require greater access to stimulus information. Indeed, the affective primacy hypothesis hinges on the assumption that the simple affective qualities of stimuli, such as good versus bad or positive versus negative, can be processed more readily than their nonaffective attributes. The mere exposure paradigm, however, provides only indirect evidence for this contention. Clearly, more direct evidence is needed.

The experimental paradigm of *priming,* in which the presentation of one stimulus, or prime, alters subjects' perceptions of a second target stimulus, may provide such evidence.[1] A priming paradigm that includes both extremely brief suboptimal and longer optimal exposures permits a sequential analysis of the effects of affect and cognition and thus lays an empirical basis for distinguishing between the two. If, as the affective primacy hypothesis suggests, global affective reactions are more immediate and less under voluntary control, we would expect that emotion-laden stimuli presented outside of conscious awareness may color our impressions and judgments to a degree unparalleled by other types of information. Consequently, if under degraded suboptimal conditions, affective priming is found to be superior to cognitive priming, then the affective primacy hypothesis will gain further support. Failure to find a systematic difference will call into question the assertion that affect can precede and therefore alter subsequent cognitions.

Precise definitions of the terms *affect* and *cognition* do not exist because definitive theories of these processes have yet to be formulated. Thus, different authors are prone to use these

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[1] Recent research in the general area of implicit memory (Roediger, 1990) uses the term *priming,* or *repetition priming,* for procedures where the stimulus sequence involves an optimal presentation followed by a presentation of the same stimulus in a degraded form, either for identification or stem completion (Tulving & Schacter, 1990). Here, we use the term *priming* mainly in its earlier meaning.

terms in different ways. Lazarus, (1982), for example, includes purely sensory processes in his definition of *cognitive* functions, whereas others reserve the term for symbolic processes that require some form of transformation of a past or present sensory input (see Zajonc, 1984, p. 118, for a more complete account of this position). Nevertheless, for present purposes some definitional distinctions are necessary. Affective reactions are equated with expressions of preference and cognitive responses with such judgments as recognition memory, feature identification, categorization, and psychophysical judgments that deal with estimates of sensory and perceptual qualities (Zajonc, 1980). We do not require either affect or cognition to be accessible to consciousness.

Of course, in everyday experience, and even in the laboratory, a total separation between affect and cognition is rare (Zajonc, 1980). After all, many affective experiences involve some participation of cognitive processes, and virtually all cognitions have some affective qualities. Moreover, any priming stimulus may be capable of eliciting affective reactions because any stimulus can be conditioned to an emotional unconditioned stimulus. Thus, even though one can postulate a total separation between affect and cognition at the abstract level of conceptual analysis, one can only hope to approximate pure instances of affect and cognition at the empirical level.

It should also be noted that it is not the priming stimulus alone that inevitably determines the type of priming being investigated. Clearly, the distinction between affective and cognitive priming effects must also take into account the emotional elements in the response that constitute the critical experimental outcome. For example, one could expose subjects to a highly emotional stimulus, say a grisly massacre scene, and ask them to make a purely cognitive response, for example, report the name of the street where it occurred. Or, one could present affectively neutral stimuli and require the subjects to indicate their preferences. Thus, regardless of what stimulus is shown or what response is measured in an experiment, a wealth of effects may be elicited so that the subject might experience a variety of affective and cognitive reactions that are not measured.

Hence, for experimental purposes, priming designated as affective should have a minimum of cognitive participation, and priming designated as cognitive should have a minimum of affective participation. The following experiments attempt to do just that. Priming stimuli had either strong affective content (e.g., faces expressing emotion) or emotionally bland content (e.g., large and small shapes). In all experiments, the primed target stimuli were Chinese ideographs. Stimulus access was manipulated by comparing extremely brief 4-ms suboptimal priming exposures with 1-s optimal priming exposures. By holding all other variables constant, these studies allow a comparison of the processing of affective and cognitive information and provide a more direct test of the primacy of affect hypothesis.

Study 1

To test the basic hypothesis that gross discriminations of positive and negative affect can be made outside of conscious awareness, and that they can precede and influence an individual's perceptions, a study was conducted in which subjects evaluated neutral stimuli, Chinese ideographs, that were preceded by either suboptimal or optimal affective primes.

Method

Subjects. Thirty-two introductory psychology students (16 men and 16 women) participated in the following experiment in partial fulfillment of a course requirement. Half of the subjects were assigned to the optimal exposure condition and half to the suboptimal exposure condition.

Materials and apparatus. Male and female faces expressing happiness and anger were selected as affective primes. Emotionally charged words, commonly used in studies of nonconscious effects (i.e., McGinnies, 1949), were not used in the present study because they may require semantic encoding before they can instigate an affective process. Supporting this conjecture, Carr, McCauley, Sperber, and Parmelee (1982) found that pictures or images activate their meanings more rapidly than do words, which require a longer processing time. Among possible affective images, faces were selected because the facial configurations associated with happiness and anger have been found to be universally recognized as indicators of positive and negative affect (Ekman, 1972), thus reducing the possibility of idiosyncratic responses to the primes.

Each face was photographed against a black background with a black cloth covering any clothing that might otherwise be visible. Photographs of five male and five female faces were assembled for use in the present experiment. Each of these 10 faces was photographed twice, once smiling and once scowling, for a total of 20 photographs.

The target masks were Chinese ideographs, selected as being affectively bland, novel, and ambiguous (Niedenthal, 1987; Zajonc, 1968). Using a backward-masking procedure to more precisely control the duration of the prime, the facial primes were always presented immediately prior to a 2000-ms exposure of one of the target Chinese ideographs.

Three slide projectors, each outfitted with a Uniblitz shutter and a red filter, were used to project 45-cm × 60-cm images onto a screen at subjects' eye level at a distance of approximately 1.5 m. This presentation resulted in a 17° visual horizontal angle and 20° vertical angle. Luminance of the screen field was approximately 60 cd/m^2. The shutters, calibrated to be accurate to within 10% of the selected shutter speed, were controlled by two Uniblitz relay control boxes (Model SD-10). An IBM-XT microcomputer controlled the slide carousels as well as the sequencing of the Uniblitz shutters.

Procedure. The cover story for the experiment was that the study dealt with snap judgments of novel stimuli. Subjects were told they would be presented with an assortment of Chinese characters that they were to rate on a 5-point Likert scale where 1 indicated they *did not like the ideograph at all* and 5 indicated they *liked the ideograph quite a bit.* Subjects were then shown slides of 45 target Chinese ideographs.

Four priming conditions, two control and two experimental, were investigated. The series of 45 trials began with 5 control trials having no prime at all (subsequently referred to as the *no-prime control*). The remaining 40 trials consisted of 20 control trials that had random polygons as primes (subsequently referred to as the *irrelevant prime control*) interspersed with 20 experimental trials that had facial primes.[2] On the 20 experimental trials, 10 of the target ideographs were shown twice, once primed with positive affect (i.e., preceded by an image of an individual smiling) and once primed with negative affect (i.e., preceded by an image of the same individual scowling). Matching each of the 10 repeated ideographs with the same individual pictured for both

[2] It is important to note here, as well as in the following studies, that the "relevance" of any particular prime is contingent on the response we require from subjects. In the present study, the random polygons are considered *irrelevant primes* because it is predicted that they will have no effect on subjects' liking judgments of the ideographs. In a subsequent study, the same polygons became *relevant primes* because subjects were asked to make judgments of symmetry of geometric figures.

the positive and negative affective primes eliminates certain extraneous sources of variance such as the relative attractiveness of both the Chinese characters and of the individual facial primes.[3] Moreover, this procedure allows us to compare the effects of positive and negative emotional primes *for the same target stimulus within the same subject*. Because subjects were unfamiliar with the ideographs, they were unaware that 10 of the 45 were repeated. Liking ratings of these 10 repeated ideographs, primed once by positive and once by negative affect, are the focus of the subsequent analyses.

In the degraded or suboptimal exposure condition, the primes were presented to subjects using a backward-pattern-masking technique, where the prime (a face) was presented for 4 ms, followed immediately by the subsequent presentation of a target stimulus (an ideograph) that also served as a backward mask. To ensure that subjects were attending to the screen during the brief suboptimal exposure, a fixation point was projected for 1000 ms at the center of the screen immediately prior to the prime, signaling the start of each trial. During the 20 experimental trials involving the 10 key ideographs, a slide of a face was flashed for 4 ms immediately prior to a Chinese character, for a stimulus-onset asynchrony (SOA) of 5 ms. On all trials, the Chinese ideograph appeared for 2000 ms, serving the dual function of pattern mask and target stimulus.

In the optimal viewing condition, the primes were shown to the subjects for a 1000-ms duration prior to the onset of the target ideographs, which were shown for a period of 2000 ms. Because subjects in this condition could clearly see the primes, they were told there would be two slides presented on each trial. To explain the presence of the primes, the experimenter alluded to "other experimental conditions" in which subjects would be asked to make different judgments involving the primes but stressed that subjects in this condition were to rate only the second slide or ideograph.

In both conditions, after subjects had rated the 45 ideographs they were questioned as to whether they had noticed anything out of the ordinary and were encouraged to speculate as to the purpose of the experiment in which they had just participated.

Forced-choice test of awareness. A number of criticisms have been leveled at experiments reporting priming effects obtained for stimuli presented under degraded conditions. For the most part, these critics doubt that there actually is a total absence of conscious detection or identification (Eriksen, 1980; Holender, 1986; Purcell, Stewart, & Stanovitch, 1983). To ensure that the degraded 4-ms exposure used in the first phase of the experiment was, in fact, at a sufficiently suboptimal level, subjects in both the suboptimal and optimal conditions were given a forced-choice test of awareness following the 45 trials, as suggested by Eriksen (1960) and others (Brody, 1988; Cheesman & Merikle, 1986). In this test, subjects were informed that they would be given a series of trials in which faces would be presented briefly, immediately followed by an ideograph. As in the experiment itself, a focal point signaled a 4-ms exposure to a prime (a face) that was immediately followed by a 2000-ms exposure to a backward mask (an ideograph). Subjects were then presented for a period of 2000 ms with two test faces: an image of the actual prime on one side of the screen and an alternate face, or foil, on the other side of the screen. Subjects were then asked which of the two faces they thought was the prime.

The rationale underlying the forced-choice test is that if the subject truly cannot detect the prime, he or she should do no better than chance at recognizing it. Because it was hypothesized that affective information may be processed outside of conscious awareness, the emotional expression of the prime and of the foil was kept constant (i.e., both smiling or both angry).[4] Gender of the facial primes also remained constant. The primes and foils were also counterbalanced such that faces that served as primes for half of the subjects served as foils for the remainder, and vice versa. Each subject participated in 12 such forced-choice trials. At the conclusion of the forced-choice test of awareness, subjects were fully debriefed and thanked for their participation.

Results

No differences were found between male and female subjects. Subsequent analyses, therefore, ignore subject gender as a factor. A 2 × 2 analysis of variance (ANOVA) was performed comparing subjects' liking ratings of the 10 repeated ideographs across the within-subject affective priming conditions (positive vs. negative) and the between-subjects exposure conditions (optimal vs. suboptimal). The results revealed a significant Prime × Exposure Level interaction, $F(1, 30) = 24.96$, $p < .001$. The precise nature of the relationship between priming and exposure level is best explained through the following analyses.

Although no subject in the suboptimal condition reported being aware of the primes, affective suboptimal priming nevertheless had a significant influence on subjects' perceptions of the 10 key ideographs, as evident in Figure 1. A paired t test revealed that when preceded by positive suboptimal primes (happy faces), target stimuli were rated significantly higher in likability than when preceded by negative suboptimal primes (angry faces of the same individuals). The mean liking of the 10 key ideographs following positive primes was 3.46, in contrast with a mean rating of 2.70 following negative primes, $t(15) = 4.87$, $p < .001$. As for the two control treatments in the suboptimal exposure condition, neither the polygons of the irrelevant prime control ($M = 3.06$) nor the absence of primes in the no-prime control ($M = 3.06$) caused ratings of the Chinese ideographs to depart significantly from the midpoint value of 3.0. Liking measures of Chinese ideographs preceded by positive and negative primes were both significantly different from those preceded by the irrelevant polygon controls, $t(15) = 2.23$, $p < .04$, and $t(15) = 2.31$, $p < .04$, respectively. The same pattern emerged between both positive and negative primes and the no-prime controls, $t(15) = 2.31$, $p < .04$, and $t(15) = 2.59$, $p < .02$, respectively. In short, the positive and negative suboptimal affective primes resulted in ratings of the target ideographs that were not only significantly different from one another but also significantly different from the no-prime and irrelevant prime controls.

In contrast, optimally presented affective priming failed to produce a significant shift in subjects' liking of the 10 repeated ideographs, although there was an effect nearing significance in the opposite direction (3.02 for positive priming and 3.28 for negative priming), $t(15) = 1.96$, $p < .08$. In the optimal condition, irrelevant polygon controls and the absence of primes resulted in liking judgments of the Chinese ideographs that did not depart significantly from the midpoint value of 3.0 (3.15

[3] There was, in fact, a significant rank-order correlation between the three independent judges' ratings of the attractiveness of the particular models smiling and the same individuals scowling.

[4] The purpose of this forced-choice test of awareness was to determine whether subjects can somehow detect and therefore recognize the suboptimal prime. Holding constant the affect of the prime and the foil should not in any way impair the subjects' ability to perceive or detect the prime. An interesting point, however, is whether nonconscious processing of affect would enable subjects to perform at a level greater than chance when a prime and a foil are affectively inconsistent (i.e., one smiling and one scowling). This issue is taken up in Study 6.

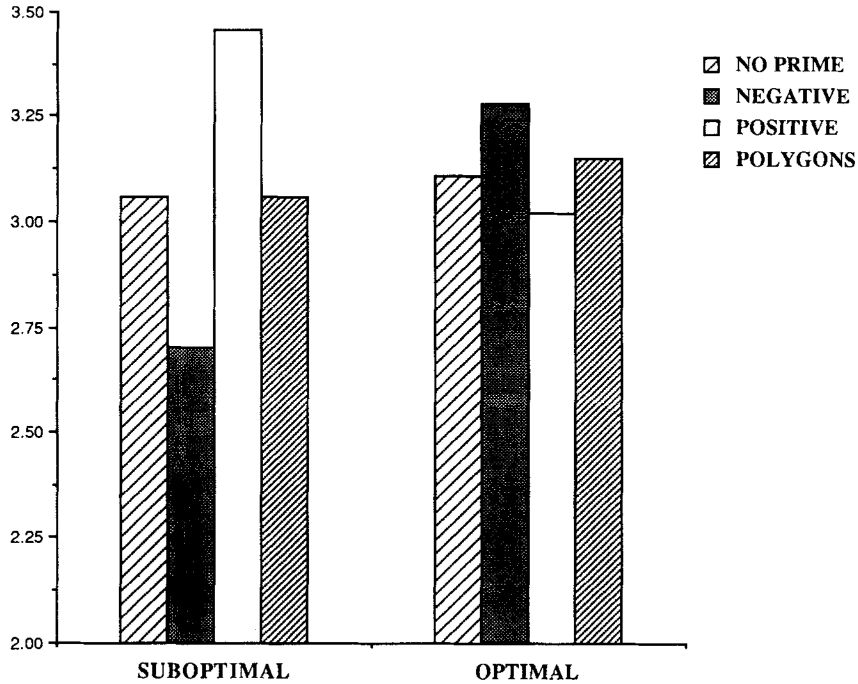

Figure 1. Mean liking ratings on a scale from 1 to 5 for the 10 key ideographs when preceded by positive as opposed to negative affective primes.

and 3.11, respectively). In fact, in the optimal condition no pair of means differed from one another at an acceptable level of statistical significance.

With regard to the forced-choice test of awareness, subjects were not able to select the prime from the incorrect alternative at a level greater than chance. Of 12 forced-choice trials subjects correctly identified the prime on average only 5.78 times, which does not differ from the chance value of 6.0, $t(31) = 1.13$, *ns.* No subject scored above 8. Moreover, even though subjects were now informed of the presence of the degraded primes, they nevertheless still maintained that they were not aware of them.

Importantly, no significant differences emerged on this forced-choice test of awareness between subjects who had previously been in the optimal condition and those who had previously been in the suboptimal condition. The failure to find higher scores among subjects in the suboptimal exposure condition, who moments earlier had been exposed to 45 trials under identical viewing conditions (thus making the 12 forced-choice trials the 46th–57th such 4-ms exposures), suggests that no practice effects occurred.

Discussion

To summarize the first experiment, suboptimal affective primes—in the form of facial expressions presented for only 4 ms—generated significant shifts in subjects' preferences for the target ideographs, whereas the same primes presented at optimal exposure durations did not. This pattern of results replicates the somewhat anomalous results of earlier researchers (Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Silverman & Weinberger, 1985; Smith, Spence, & Klein, 1959) in that the magnitude of the priming effect was inversely related to the length of exposure to the primes, with only suboptimal exposures producing any significant effects.

But why is it that the identical affective information seems more potent when presented at a level that *is not accessible to consciousness?* Relevant here are data reported by Seamon, Marsh, and Brody (1984), who found that the temporal advantage of affective discrimination over cognitive discrimination is reversed when the stimuli are exposed for longer durations. Their results show that people can make reliable affective discriminations given only minimal exposures, with preference for the previously exposed stimulus at about 60%. However, the level of this preference remains at 60% even when the exposures are extended to considerably longer durations. In contrast, recognition memory is unreliable at very short durations—less than 8 ms—but it continues to improve with longer exposures, reaching levels above 80%.

Spence and Holland (1962) noted 30 years ago that conscious and nonconscious processes were commonly viewed as representing two different locations on a single continuum. "A response based on partial cues is on the same continuum with a response to a fully developed stimulus, but the former is a paler and less precise copy of the latter" (p. 163). Following this logic increasing awareness should result in making information more accessible to the person and thus increasing the "fit" between stimulus and response. This view, Spence and Holland noted, is contradicted by findings that obtain stronger effects with degraded stimuli (Eagle, 1959; Paul & Fisher, 1959; Smith et al., 1959). Spence and Holland argued that the "degree of awareness of a stimulus at the moment of input cannot be used to predict the extent of its effect on a response" (p. 164).[5]

Öhman, Dimberg, and Esteves (1989) also proposed a continuum model of consciousness. However, they allow emotion to enter the information-processing chain early, before more complex perceptual stimulus features are encoded. It would follow, then, that at very degraded exposure levels affective influences might take place, giving rise to gross affective reactions. At very short exposures, these reactions are unencumbered by other more complex information that requires fuller access if it is to be appropriately encoded. At optimal exposures, the individual is capable of accessing not only the primitive and gross affective significance of the stimulus but is also able to glean additional affective input from a more extensive cognitive appraisal. At longer exposures, then, the stimulus is likely to activate a complex network of associations allowing for feature identification and recognition. To the extent that the primitive and gross early emotional effects are consistent with the subsequent cognitive appraisal (Lazarus, 1982), no pronounced differences between suboptimal and optimal levels of exposure should be obtained. If, however, the subsequent information contradicts or dilutes the primary affective reaction, the possibility exists that the two sources of influence could nullify each other, thus canceling the priming effect. It may be the case that subjects in the suboptimal condition of the present study were only able to make gross positive or negative discriminations of the priming stimulus, (i.e., there was only the smile or the scowl). However, as exposure time increased to 1000 ms, more information about specific features of the face, such as attractiveness, hair color, and complexion, became available. These features, if inconsistent with the valence of the facial expression, may have diluted subjects' affective reactions and canceled the priming effect. Imagine, for example, the mixed messages evoked by a physically attractive but angry stranger.

Figures 2 and 3 show diagrammatically the theoretical predictions described by the above model. The unbroken curves in Figure 2 represent positive (A^+) and negative (A^-) affective reac-

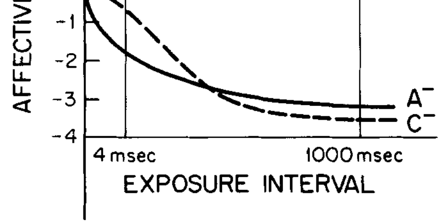

Figure 2. Theoretical values of affective reactions based on early affective (A^+ and A^-) and slower cognitive access (C^+ and C^-).

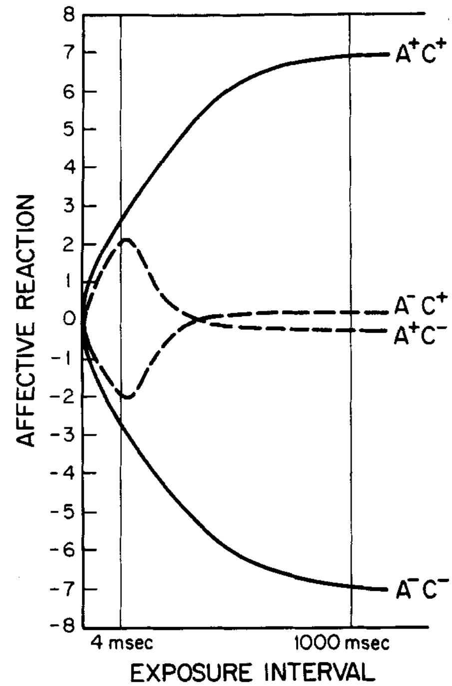

Figure 3. Theoretical values of affective reactions accumulating from early affective access (A^+ and A^-) and subsequent cognitive appraisal (C^+ and C^-). (Continuous curves represent accumulation when the two sources are consistent; broken curves represent inconsistent sources.)

tions to the priming stimulus brought about by early direct access (i.e., the smile or scowl alone). However, an affective reaction based on a cognitive appraisal, that might involve more multifaceted feature identification and evaluation, would require considerably longer priming exposures. These cognitive appraisal elements, C^+ for positive and C^- for negative appraisal, are shown in broken curves and have a slower rise pattern than the A^- curves. Note that the differences between A^- and C^- curves are quite similar to those reported by Seamon et al. (1984).

We assume here that, in general, affective reactions are based on all available sources, including both early direct access and later cognitive appraisal. It can be further assumed that these sources combine. These cumulative affective reactions based on early and late access are shown in Figure 3. Thus, if the early direct access source is positive and the subsequent cognitive appraisal leads to a positive evaluation as well (A^+C^+), we would expect generally positive priming. Alternatively, if the early direct access generates a positive affective reaction (pèrhaps due to a smiling face) and the later cognitive appraisal is negative (perhaps from a disheveled appearance, as in the curve marked A^+C^-), we would expect a dilution of the earlier reaction. The degree to which the initial affective reaction is diluted will depend on the valences of these two sources and on the weights each may be assigned in a given judgment.

[5] These authors spoke mainly of effects on the processing of cognitive content. When distinctions are made between affective and cognitive inputs, some of the contradictions disappear, as is later shown.

If the dilution explanation of the above results is correct, we would expect the responses of subjects in the optimal exposure condition to be a function of both the early affective cues as well as those requiring a more extensive appraisal. More specifically, the strongest optimal priming effects should occur when the initial affective reaction coincides with secondary affective cues such as appearance (namely, scowling unattractive primes or smiling attractive primes). These are represented by the curves A^-C^- and A^+C^+.

To test this dilution hypothesis, three independent judges were invited to rank order the 10 positive and negative primes for attractiveness. The concordance in attractiveness rankings was .91 ($F = 20.50$, $p < .001$) for the 10 smiling faces and .90 ($F = 18.07$, $p < .001$) for the scowling faces. The data were then broken down by attractiveness within each valence, and the effects of the three primes judged most attractive were compared with the effects of the three primes judged least attractive. Ratings of the target ideographs that followed these selected primes were entered into a 2 (attractiveness: attractive vs. unattractive) × 2 (affect: positive vs. negative) within-subjects ANOVA run separately for the optimal and suboptimal exposure conditions.

As shown in Table 1, at optimal exposures the three most attractive faces resulted in higher liking ratings of the Chinese ideographs than did the three least attractive faces (3.23 and 2.88, respectively), $F(1, 15) = 4.28$, $p < .06$. As predicted by Figure 3, the contrast was most pronounced between attractive smiling faces (A^+C^+), which resulted in an average rating of 3.25, and unattractive scowling faces (A^-C^-), which were associated with an average rating of 2.77. This difference was significant at $p < .01$, $t(15) = 3.15$. At optimal exposures there was, however, no significant main effect for the affective valence of the primes. In other words, optimally presented smiling and angry faces were relatively ineffective in influencing subjects' liking of the ideographs (3.12 and 2.99, respectively), $F(1, 15) = 0.75$, $p < .40$.

In the suboptimal exposure condition, the opposite pattern of results emerged. When the primes were presented suboptimally, there was no significant main effect for attractiveness, with attractive primes producing a mean liking rating of 3.08 and unattractive primes producing a mean liking rating of 3.15, $F(1, 15) = 0.24$, $p < .63$. At the same time, the suboptimal primes did produce a significant main effect with regard to affect. Smiling faces yielded a mean liking rating of 3.50 in comparison with scowling faces, which resulted in a mean liking rating of 2.73, $F(1, 15) = 21.59$, $p < .001$.

Of course there are problems associated with this post hoc analysis. First, we must keep in mind that these faces were not initially selected on the basis of attractiveness. Moreover, the attractiveness of a particular face may have been correlated with the ability to produce an effective smile, thus confounding the analysis. The hypothesis that the attractiveness of a face operates primarily at higher levels of stimulus accessibility, however, is supported by the fact that under suboptimal conditions, ranked attractiveness had no effect on liking ratings whatsoever —a result that is consistent with the continuum hypothesis in Figure 3.

Table 1
Mean Liking Ratings for Ideographs Preceded by the Three Most Attractive and Three Least Attractive Facial Primes

	Affect		
Condition	Positive	Negative	Average
Optimal			
Attractive	3.25	3.21	3.23
Unattractive	2.98	2.77	2.88
Average	3.12	2.99	
Suboptimal			
Attractive	3.58	2.58	3.08
Unattractive	3.42	2.88	3.15
Average	3.50	2.73	

Study 2

There is, however, an alternative explanation for the failure in Study 1 of obtaining effects with primes presented at optimal exposures. In general, the subjects cannot be "wrong" when making evaluative judgments that reveal their own preferences. As beauty lies in the eye of the beholder, one's subjective liking for an object cannot possibly be incorrect. Perhaps subjects in the optimal exposure condition resented the faces looming in front of them, viewing them as a blatant attempt to sway their opinions. Perhaps, as a consequence, they sought to assert their independence and responded with reactance when judging the ideographs.

The first study was, therefore, replicated with the important modification that we now asked for an affective judgment of a more objective nature. Instead of asking subjects how well they liked the ideographs, we had them report whether they felt the ideographs represented "good" or "bad" objects. Now, any reactant behavior on the part of the subjects would, we hoped, be mitigated by the possibility that they could be wrong.[6]

Method

Study 2 used the identical procedure and apparatus as that used in Study 1, with one exception. Using the same experimental primes as in the liking study (happy and angry faces) and the same control primes, 32 subjects (16 men and 16 women) were asked to rate whether they felt each target ideograph represented a good or pleasant object by indicating a high score or an unpleasant or bad object by indicating a low score on a scale ranging from 1 to 5. It was stressed that each ideograph represented an actual object, the implication being that there was a correct answer. Half of the subjects took part in the optimal exposure condition and half in the suboptimal exposure condition.

Results

As in Study 1, a 2 × 2 ANOVA focusing on the effects of affective prime and exposure level on subjects' ratings of the 10 key ideographs was performed. These data revealed a main effect for affective prime, $F(1, 30) = 7.16$, $p < .01$, with positive primes being associated with higher good ratings than negative primes. Once more, exposure level did not yield a main effect,

[6] Similar good-bad judgments have been used previously with considerable success as proxies for affective reactions (Greenwald, Klinger, & Liu, 1989; Kunst-Wilson & Zajonc, 1980; Zajonc, 1968).

$F(1, 30) = 0.34$, $p < .56$, but as in Study 1, there was a significant Prime × Exposure Level interaction, $F(1, 30) = 4.72$, $p < .04$.

Once again suboptimal affective priming had a significant impact on subjects' perceptions of the 10 key ideographs. As evident in Figure 4, when preceded by positive suboptimal affective primes, the target ideographs were rated higher than the same ideographs preceded by negative suboptimal primes (3.28 and 2.61, respectively), $t(15) = 2.70$, $p < .02$. Thus, in a situation where subjects' reactance could lead to errors, essentially the same results were obtained as when liking was used as the dependent measure. Priming with the irrelevant control primes, or polygons, resulted in a mean of 3.05 on the good–bad continuum that was virtually identical to the no-prime control (3.06). Neither of these controls were significantly different from the midpoint value of 3.0. Both positive and negative primes, however, were significantly different in their effects on good–bad judgments from the effects of the polygons and the no-prime controls ($p < .05$ for all comparisons).

Affective priming using full exposures, on the other hand, while showing a trend in the same direction, did not produce a significant shift in subjects' ratings of whether the ideographs represented a good or bad object. Following a positive prime, subjects gave the 10 key ideographs an average rating of 2.84, whereas the same ideographs following a negative prime received an average rating of 2.77, $t(15) = 0.57$, *ns.* It is important to note that this effect, although insignificant, was in the opposite direction from that obtained in the previous study using liking judgments. In other words, it appears that although subjects may resent being told what they like, they may be more open to suggestion regarding whether an ideograph refers to a good or bad object. Optimal priming with the irrelevant control polygons resulted in an average good–bad judgment of 2.97, and in the no-prime control the good–bad judgments had a mean of 2.99, both negligibly removed from the midpoint value of 3.0. No significant differences between any pair of means were found in the optimal condition.

Finally, subjects were not able to perform above a chance level on the forced-choice test of awareness. As in Study 1, primes of faces were presented suboptimally for 4 ms and then immediately masked by an ideograph. Subjects were then presented with two faces of the same gender expressing the same emotion and asked to indicate which they thought was the suboptimal prime. The mean accuracy level on this test was 5.72 out of a possible 12, very near the chance level of 6.0, $t(31) = 1.39$, *ns.*

Discussion

In contrast with the liking judgments of Study 1, subjects in the optimal condition of the present study, when faced with deciding whether an object referred to something good or something bad, tended to respond in a direction consistent with the affective primes. In other words, subjects reported the 10 key ideographs as more likely to represent pleasant objects when preceded by clearly visible smiling primes than when preceded by slides of the same individuals scowling. Although this trend

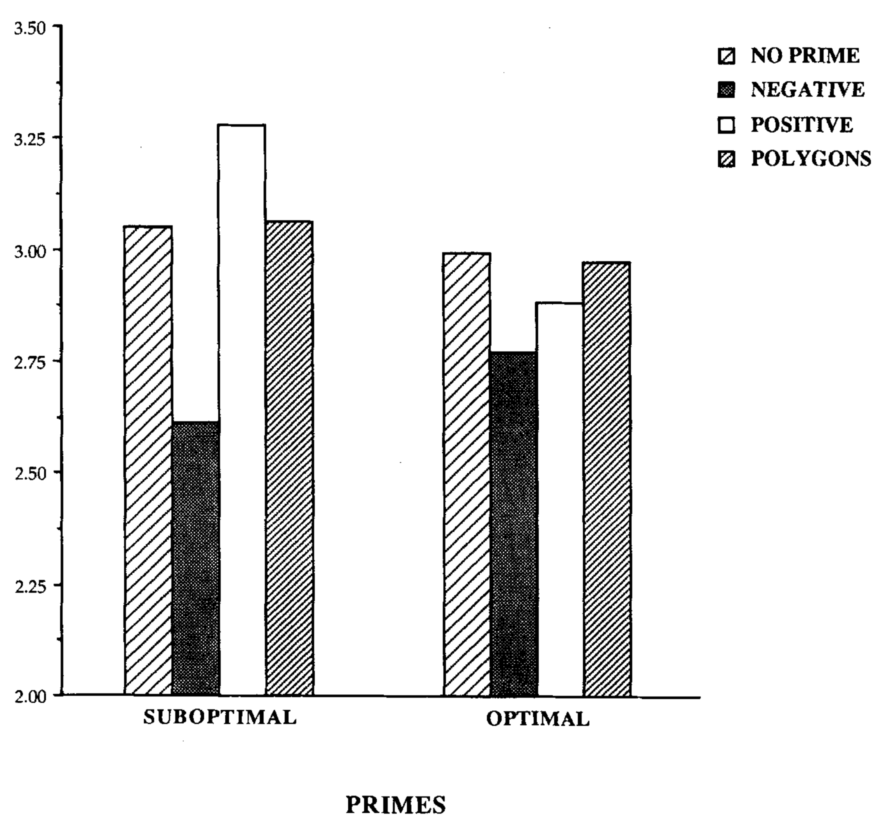

Figure 4. Mean ratings on the good–bad dimension for the 10 key ideographs when preceded by positive as opposed to negative affective primes.

did not reach an acceptable level of statistical significance, it was nevertheless markedly different from the marginally significant contrast effect of the previous study where positive optimal primes led to lower liking ratings than negative optimal primes. This reversal may be due, in part, to subjects' belief that there was a correct answer. It may also be the case that liking is a unique sort of judgment in that one's preferences are in some sense sacred. Perhaps subjects in the present experiment did not experience the same reactance to a perceived attempt to influence their judgments of the meaning of Chinese ideographs. This discrepancy between the optimal conditions in Studies 1 and 2 heightens our suspicion that the nature of the judgment can constrain or substantially alter the influence of affective primes, at least those that are available to conscious awareness.

No inconsistency existed, however, for the suboptimal affective priming conditions in the first two studies. Regardless of whether subjects were reporting their preference for the ideographs or judging if the ideographs represented good or bad objects, the results were the same—positive suboptimal priming generated more positive ratings, whereas negative suboptimal priming led to lower ratings.

If the continuum of consciousness hypothesis is correct, and if the previously noted differences between optimal and suboptimal priming reflect the fact that early affective reactions are diluted by later incongruent information presented at longer exposures, then we would again expect the attractiveness of the primes to be a factor at optimal exposures. In other words, at optimal levels of accessibility attractive smiling primes should elicit higher mean good responses than unattractive smiling primes. At degraded exposure levels, however, the attractiveness of the primes should make less difference.

To examine the continuum hypothesis in Study 2, a post hoc analysis of the three most attractive and the three least attractive primes, identical to that in Study 1, was conducted (see Table 2). Strong attractiveness effects were found in the optimal condition. There was an overall main effect for attractiveness, with the three most attractive primes resulting in significantly higher scores on the good–bad dimension than the three least attractive primes (3.28 vs. 2.81, respectively), $F(1, 15) = 9.47$, $p < .01$. Again, as in Study 1 and consistent with the predictions made in Figure 3, the most striking contrast was between attractive smiling faces (A^+C^+), which resulted in good–bad judgments of the target ideographs having a mean of 3.81, and unattractive angry faces (A^-C^-), which resulted in a mean of 2.31, $t(15) = 3.73$, $p < .01$. Unlike in Study 1, however, there was also a significant main effect for affect, with smiling faces resulting in higher mean good ratings (3.56) than angry faces (2.53), $F(1, 15) = 10.51$, $p < .01$.

As in Study 1, there was no effect for attractiveness of the primes among subjects in the suboptimal condition, suggesting that this information was not immediately accessible, $F(1, 15) = 0.06$, $p < .82$. Once again, suboptimal smiling primes resulted in higher ratings on the good–bad dimension than suboptimal angry primes (3.35 vs. 2.71), although this trend did not reach an acceptable level of statistical significance, $F(1, 15) = 1.90$, $p < .18$.

Table 2
Mean Good–Bad Ratings for Ideographs Preceded by the Three Most Attractive and Three Least Attractive Facial Primes

Condition	Affect: Positive	Affect: Negative	Average
Optimal			
Attractive	3.81	2.75	3.28
Unattractive	3.31	2.31	2.81
Average	3.56	2.53	
Suboptimal			
Attractive	3.46	2.54	3.00
Unattractive	3.23	2.88	3.06
Average	3.35	2.71	

Study 3

Although the findings of the first two studies confirm our expectations that some emotional stimuli of which we are unaware can color our judgments, they leave unanswered the question of whether nonconscious affect is unique in its ability to sway subsequent judgments. It may be the case that any relevant prime, regardless of whether it is emotional in nature, is more potent when presented suboptimally than when presented with full access to awareness. On the other hand, if affective information is processed faster and more efficiently than other types of information, as the affective primacy hypothesis suggests, then we would expect very weak or even nonexistent effects at the suboptimal level when cognitive judgments such as simple psychophysical decisions are primed by affectively bland but relevant stimuli.

Method

To test the above proposition, a third experiment was conducted using simple affectively bland primes—large and small circles and squares. Once again, Chinese ideographs served the dual role of target stimuli and pattern masks. Whereas the no-prime control condition was the same as in the previous studies, faces with relaxed, emotionally neutral expressions now served as irrelevant control primes.

Subjects. As in the previous studies, 32 introductory psychology students (16 men and 16 women) participated in the following experiment in partial fulfillment of a course requirement. Half of the subjects were assigned to the suboptimal and half to the optimal exposure condition.

Procedure. Subjects in this experiment, again ostensibly dealing with judgments of novel stimuli, were asked to rate 45 ideographs (the same as in Studies 1 and 2) with respect to size of the object each represented, where 1 indicated that a particular ideograph represented a relatively small object (like a bird or a mouse) and 5 indicated that an ideograph represented a relatively large object (like a tree or a house). The ideographs were all roughly equal in size. This time, the 10 critical repeated ideographs were preceded once by a relatively small prime (either a circle or square) and once by a larger version of the same shape. As in the previous studies, the first 5 trials had no primes at all. The remaining 40 trials consisted of 20 experimental trials showing circles and squares of different sizes and 20 irrelevant control trials showing neutral faces. The order of the trials was once again the same for all subjects.

At the conclusion of this phase of the experiment, subjects were informed of the true nature of the study and underwent a forced-choice test of awareness, as described in Study 1. Subjects in this test, however, were shown a series of 12 ideographs, each suboptimally primed by a 4-ms exposure to a large or small shape. They were then presented with an image of the prime on one side of the screen and a foil (an image of the same shape but alternate size) on the other and asked to indicate which image was the suboptimal prime.

Results

Subjects' estimates of the size of the objects the 10 key ideographs represented were entered into a 2 (prime: small vs. large) × 2 (exposure level: suboptimal vs. optimal) ANOVA. These data revealed a significant main effect for the size of the prime, $F(1, 30) = 20.47$, $p < .001$, with larger primes generating increased size estimates of the object the ideograph represented. Level of exposure also produced a marginally significant main effect, $F(1, 30) = 3.56$, $p < .07$. As previously, there was also a strong Prime × Exposure Level interaction, $F(1, 30) = 16.47$, $p < .001$, with optimal primes producing far more substantial shifts in size ratings than suboptimal primes. Again, there were no gender differences in these results, and, consequently, this factor was ignored in subsequent analyses.

Size ratings of the target ideographs preceded by small suboptimal primes did not significantly differ from ratings of the same target ideographs when preceded by large suboptimal primes (3.87 and 3.93, respectively), $t(15) = 0.41$, *ns.* The irrelevant neutral faces (3.89) and no-prime controls (3.91) also had no effects under suboptimal exposure conditions, and there were no differences between the effects of these control primes and the experimental (large and small) primes. In short, none of the four types of suboptimal primes yielded ratings significantly different from one another.

In stark contrast with affective primes, optimally presented size primes did significantly influence subjects' perceptions of the identical ideographs, $t(15) = 4.47$, $p < .001$. Specifically, when an ideograph was preceded by a large, clearly visible prime, subjects rated the ideograph as representing a larger object than when the same ideograph was preceded by a small prime (4.01 vs. 3.05). As is apparent from Figure 5, ratings of the two control primes (3.51 for the irrelevant control primes and 3.80 for the no-prime controls) also differed from the two experimental primes ($p < .05$, with the exception of the planned comparison between large primes and no primes). In sum, whereas suboptimal size primes produced no significant effects, the same primes presented at optimal exposures showed distinct changes in subjects' size judgments of the ideographs.

In the forced-choice test of awareness, using large and small shapes, subjects once again failed to discriminate at a level greater than chance between the actual prime and a foil. On the average only 5.97 out of 12 items (roughly a chance pattern) were correctly identified, $t(31) = 0.13$, *ns.*

Study 4

Unlike the affective primes of Studies 1 and 2, size primes produced no significant shifts in judgment at the suboptimal level, whereas the same primes presented at optimal exposures clearly influenced subjects' size judgments of the ideographs. This finding is consistent with the premise that affective information may be processed earlier than information, such as size, that is not generally affective in nature.

There is, however, an alternative explanation. Perhaps the results of the last study are in part due to the nature of the response required of the subjects. In Study 3, subjects were required to guess the *meaning* of a Chinese ideograph in terms of the size of the object it represented. This response was selected to retain a parallel with Study 2, where subjects had to report whether an ideograph referred to a good or bad object. Although during debriefing some subjects were able to articulate a rule or heuristic they used in their judgments, many admitted that they were merely guessing. The question then arises as to whether the same results would be obtained in a domain where the subject believes himself or herself to be fully competent of making judgments. In other words, would we have obtained the same results if subjects did not feel as though they were guessing? Earlier research by Spence and Holland (1962) has shown that suboptimal primes can only produce effects on behavior if they are not in competition with other, more powerful conscious influences. Thus, it is plausible that if subjects were forced to concentrate on the objective features of the ideographs they may no longer be susceptible to relevant primes at either the suboptimal or optimal level. To address this issue, a separate study was conducted using symmetric and asymmetric shapes as primes to determine whether these primes could influence subjects' judgments of the actual symmetry of the target ideographs.

Method

Thirty-two subjects (16 men and 16 women) participated in the experiment. Half were assigned to the 4-ms suboptimal condition and half to the 1000-ms optimal exposure condition. The symmetric primes were the large circles and squares from Study 3. The asymmetric primes were irregular polygons with jagged edges. Again, neutral faces served as irrelevant control primes. This time subjects were asked to judge the symmetry of the actual ideographs themselves as opposed to the objects they represented.

Results

A 2 × 2 ANOVA (Symmetric vs. Asymmetric Prime × Suboptimal vs. Optimal Exposure Level) was performed on subjects' symmetry ratings of the 10 key ideographs. Neither prime nor exposure level produced a significant main effect, $F(1, 30) = 1.80$, $p < .19$, and $F(1, 30) = 0.33$, $p < .57$, respectively. There was, however, once more a significant Prime × Exposure Level interaction, $F(1, 30) = 4.06$, $p < .05$.

No effects were found for symmetric and asymmetric suboptimal primes (2.09 and 2.13, respectively), $t(15) = 0.43$, *ns.* Moreover, as indicated in Figure 6, no differences were found among any of the four suboptimal group means, including the control primes (2.19 for the irrelevant primes and 2.14 for the no-prime control).

However, as in Study 3, a significant difference emerged in subjects' ratings of the same ideographs following the 1000-ms presentation of primes. In the optimal condition where they could clearly perceive the primes, subjects reported that the identical ideographs were more symmetrical following the symmetric primes than the asymmetric primes (2.28 and 2.09, respectively), $t(15) = 2.65$, $p < .02$. Also paralleling Study 3, the irrelevant neutral face control and the no-prime control fell in between the two extremes of symmetric and asymmetric primes (2.25 and 2.15, respectively). It is important to keep in mind that in this experiment subjects were not asked whether

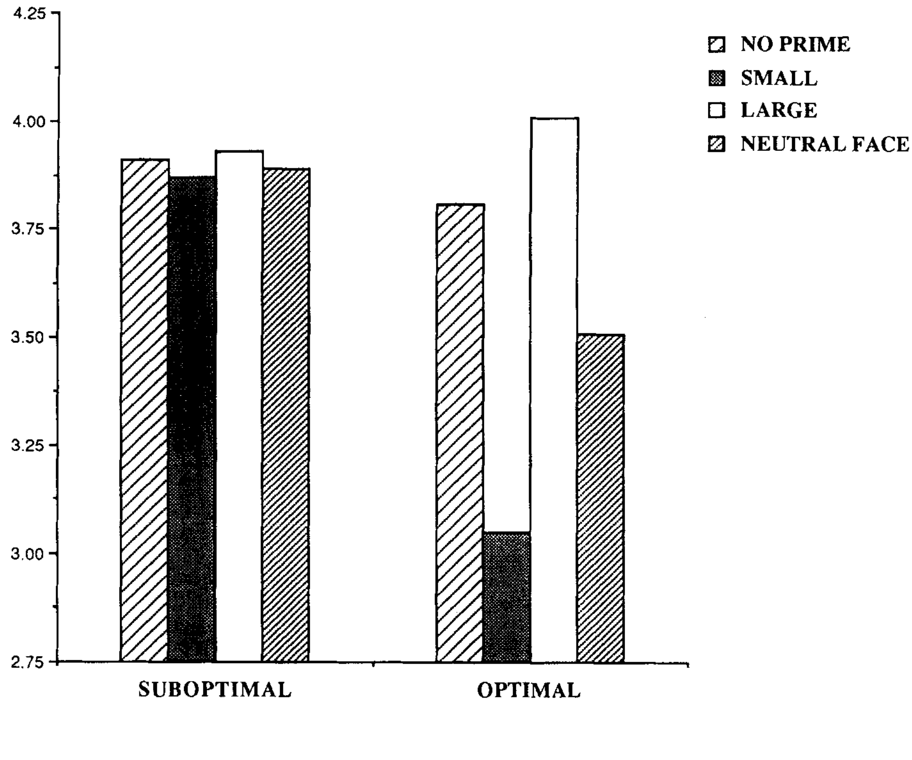

Figure 5. Mean size ratings on a scale from 1 to 5 for the 10 key ideographs when preceded by small as opposed to large primes.

the ideograph meant something symmetric or not but whether it was, in fact, geometrically symmetric.

The subsequent forced-choice test of awareness, this time using symmetric and asymmetric shapes, revealed only chance-level discrimination (6.15), $t(31) = 0.69$, *ns.* As in the previous studies no systematic difference emerged on the forced-choice test between subjects in the suboptimal and optimal conditions, suggesting that no practice effects occurred.

Discussion

Subjects in the optimal condition of the present study, despite having access to the objective features of the ideographs, were nevertheless swayed by the presentation of clearly visible symmetric and asymmetric primes. It is interesting to note, however, that although statistically significant, the magnitude of this effect is substantially smaller than that of the previous study where subjects were asked to estimate the size of the objects the ideographs represented. This suggests that perhaps subjects' judgments of the symmetry of the ideographs may have been constrained by objective reality.

The suboptimal presentation of these same symmetric and asymmetric primes had absolutely no effect on subjects' judgments of the symmetry of the ideographs. This finding is consistent with the prediction that the suboptimal presentation of affectively neutral primes, namely, geometric shapes, would not produce the same shifts in judgment as affective primes. These results support a continuum theory of consciousness in which some forms of stimulation have access mainly at higher levels of exposure. In this particular case, the judgmental response to simple geometric shapes (represented by the C curves in Figure 2) seems to require a longer exposure than does an affective response to an emotional stimulus (represented by the A curves in Figure 2). Thus, the effects of simple geometric primes on nonevaluative cognitive judgments in Studies 3 (size) and 4 (symmetry), which showed significant optimal priming but no suboptimal priming, are the mirror image of the effects of emotional primes on evaluative judgments as seen in Studies 1 (liking) and 2 (good–bad).

Study 5

At least one plausible alternative explanation, other than the affective primacy hypothesis, might account for the findings presented thus far. It is important to note that the priming stimuli in Studies 3 and 4 differed in more than one way from those in Studies 1 and 2. The priming stimuli in Studies 3 and 4 (geometric shapes) were simple, abstract, and socially insignificant. In contrast, the priming stimuli in Studies 1 and 2 (faces) were complex, concrete, socially significant, and perhaps ones to which emotional reactions are "hard wired." It could be argued, therefore, that the perceptual response to human faces may have particular properties.

The theory that the face may be a unique stimulus has some support. Perrett, Rolls, and Caan (1982), for example, have located cells in the temporal sulcus of the monkey that respond to

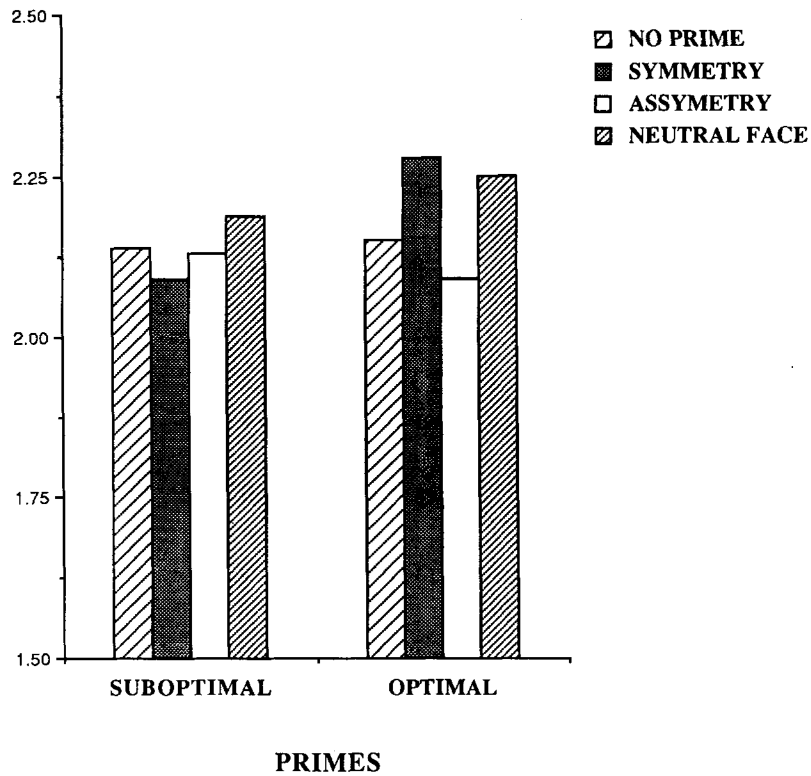

Figure 6. Mean symmetry ratings on a scale from 1 to 5 for the 10 key ideographs when preceded by symmetrical as opposed to asymmetrical primes.

the presentation of faces and only faces. Moreover, spontaneous mimicry of emotional expressions has been demonstrated in neonates as early as 36 hr after birth, suggesting that we may be innately prepared to perceive and respond to facial cues (Field, Woodson, Greenberg, & Cohen, 1982). Research by Dimberg (1982) further revealed that mimicry of facial expressions can take place involuntarily, outside of conscious awareness. It may be the case, therefore, that any information conveyed by a face, emotional or otherwise, holds a perceptual advantage. The question then is whether the suboptimal effects obtained in Studies 1 and 2 are dependent on the fact that faces were used as primes or rather on the fact that these faces elicited affect.

To examine this alternative explanation of the preceding results, another study was conducted using faces as primes but requiring a nonevaluative judgment from the subjects. This time, by presenting primes that consisted of male and female faces, we attempted to influence subjects' perceptions of whether an ideograph referred to a masculine or feminine object. Of course, even emotionally bland faces are not affectively bland stimuli. However, we now asked subjects to make a fairly nonevaluative discrimination based on nonaffective information conveyed by these faces. If both affective and nonaffective information conveyed by a face holds a perceptual advantage, then we would expect that, as in Study 1, the suboptimal presentation of male and female primes would influence subjects' perceptions of the ideographs, as in Studies 1 and 2. On the other hand, if the gender-related information contained in these faces is primarily cognitive and therefore processed further along the conscious access continuum, then the results should resemble those of Studies 3 and 4, showing no evidence of suboptimal priming.

Method

Thirty-two subjects (16 men and 16 women) in this experiment were asked to judge whether each of the 45 ideographs represented a feminine or masculine object on a scale from 1 to 5 where a rating of 1 indicated *masculine or not at all feminine* and 5 indicated *quite feminine.* In this study, the 10 repeated ideographs were preceded once by a female face and once by a male face. In an attempt to make the male and female primes as distinct from one another as possible, all male primes had short hair, whereas all female primes had hair shoulder length or longer. The faces expressed no emotional reactions other than a relaxed neutral aspect. Again, as in Studies 1 and 2, polygons served as irrelevant control primes, and there was also a no-prime control condition. Half of the subjects were exposed to these primes for only 4 ms and half for 1000 ms, and both exposures were immediately followed by an ideograph that appeared on the screen for 2000 ms.

Following the experiment proper, subjects were given a forced-choice discrimination task using neutral male and female faces as primes and foils.

Results

Femininity ratings of the 10 key ideographs were subjected to a 2 (prime: male vs. female face) × 2 (exposure level: suboptimal vs. optimal) ANOVA. The results indicate a significant main effect for the gender of the prime, $F(1, 30) = 9.16$, $p < .005$, with female primes producing higher ratings than male primes.

There was no significant main effect for exposure level, $F(1, 30) = 2.14$, $p < .15$. However, as in each of the preceding studies there was a robust Prime $\times$ Exposure Level interaction, $F(1, 30) = 10.23$, $p < .003$.

The suboptimal primes of male and female faces had no significant effect on subjects' subsequent judgments of femininity (2.66 and 2.67, respectively; see Figure 7). Likewise, control prime conditions produced no distinct effects (2.63 for both the no-prime and irrelevant prime control). In the suboptimal condition, therefore, none of the four group means were significantly different from any other.

Optimally exposed primes, on the other hand, did significantly influence perceptions of femininity, with female primes producing higher ratings than male primes (3.19 vs. 2.74), $t(15) = 4.01$, $p < .001$. The control primes fell halfway between the masculine and feminine primes, with the irrelevant control primes (polygons) resulting in a mean femininity judgment of 2.93 and the no-prime condition resulting in a femininity judgment of 2.95. The pattern of results from this gender manipulation, then, was virtually identical to that of the size and symmetry manipulations, namely, ineffectual suboptimal priming and effective optimal priming.

The forced-choice test of awareness, using emotionally neutral faces of opposite gender, revealed only chance-level discrimination between the prime and the incorrect alternative, with an average score of 5.56 out of a possible 12, $t(31) = 1.62$, *ns.*

Discussion

The pattern of results thus far agrees with the continuum model presented in Figures 2 and 3. Affective priming that used positive and negative facial expressions as primes shows effects under very brief exposures, whereas priming using nonaffective stimuli varying on such dimensions as size, symmetry, and gender shows effects primarily under lengthy exposure durations. As in Figure 2, A curves seem to have a faster rise time than C curves. It appears, therefore, that affective reactions may be evoked preattentively with extremely brief access to stimulus information (Kitayama, 1991). Because of this early access, affective reactions may have significant influence over how later information, even information regarding entirely unrelated and distinct stimuli, is processed and evaluated. Within the limits of these studies we have simply assumed that information accessed early and that accessed later combine. It is entirely possible that early affective reactions may interact in other important ways with subsequently accessed information. The precise nature of this interaction is of interest in its own right but is beyond the scope of this article.

Study 6

It is, however, within our power to examine the conditions of exposure in the aforementioned experiments. It follows from the previous findings that affective and cognitive reactions may under certain circumstances require different degrees, or perhaps even a different form, of access to awareness. Some evidence on this point comes from the forced-choice tests of awareness that were administered following each of the previous studies. Even after having been informed that suboptimal primes were being presented prior to each ideograph during this phase, subjects nevertheless maintained that they "couldn't see any-

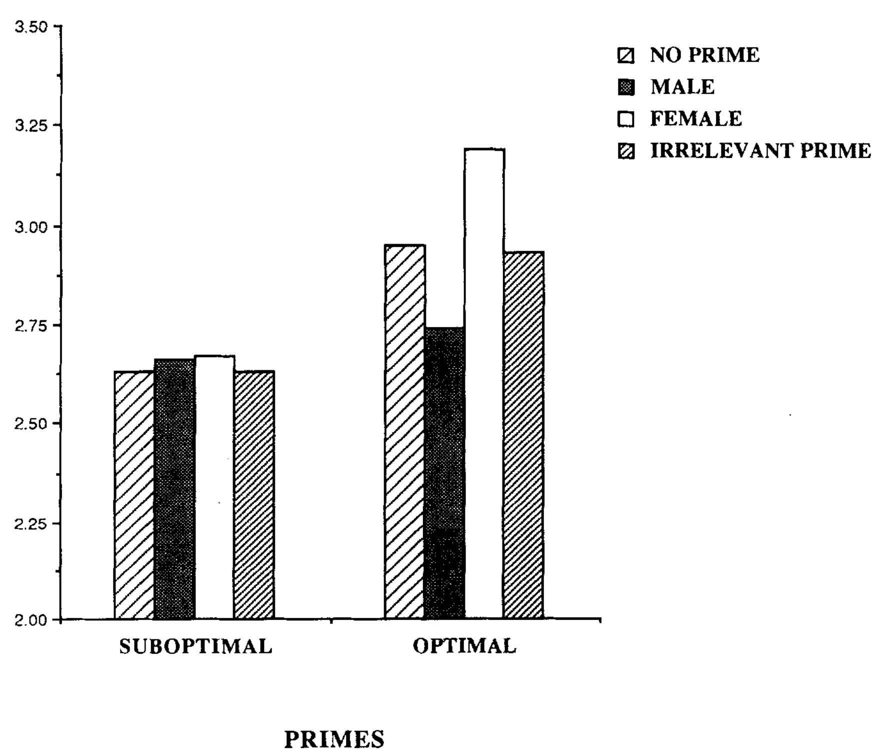

Figure 7. Mean femininity ratings on a scale from 1 to 5 for the 10 key ideographs when preceded by female as opposed to male primes.

thing," satisfying a subjective criterion of awareness (Cheesman & Merikle, 1986). Moreover, this denial of awareness was supported by subjects' subsequent failure to perform with better-than-chance accuracy on the objective forced-choice tests of awareness. The present studies, therefore, demonstrate the suboptimal influence of affect in conditions that meet both a subjective criterion of awareness (Cheesman & Merikle, 1986) and a more stringent objective criterion (Eriksen, 1960).

The failure of subjects to discriminate at a level greater than chance on the test of awareness raises an interesting theoretical point. Recall that in these forced-choice tests, the emotional valence of the prime and of the incorrect alternative or foil was kept constant: either both smiling or both scowling. Under these conditions, subjects were unable to correctly identify the suboptimal prime at a level greater than chance. Both the liking judgments of Study 1 and the good–bad judgments of Study 2, however, clearly indicate that gross positive and negative affective priming effects can be obtained even when subjects fail to show any objective or subjective awareness of the priming stimuli.

It follows, therefore, that subjects should be able to perform better than chance on a forced-choice test of awareness if they are asked to chose between faces that express affectively inconsistent emotions. Moreover, because the objective stimulus properties of the suboptimal primes (size, symmetry, and gender) did not influence subsequent nonevaluative judgments, subjects should not be able to discriminate between two faces that differ on an objective aspect such as gender. The following experiment tested this proposition.

Method

Subjects. Sixty-four introductory psychology students (32 men and 32 women) participated in the experiment in partial fulfillment of a course requirement.

Materials and apparatus. Twelve pairs of photographs of male and female faces expressing happiness and anger were selected as affective primes. To make the gender of the primes easily distinguishable, all 6 male models had uniformly short hair, whereas all 6 female models wore their hair shoulder length or longer. Twelve Chinese ideographs from the previous studies served as masks. The apparatus that served to project stimuli and control luminance and exposure duration were the same as in the previous studies.

Procedure. On arrival, subjects were informed that they would be exposed to a series of faces for intervals so short that they may not be aware of having seen anything. Nevertheless, on each trial they would be asked to guess which of two faces was, in fact, the face that was presented suboptimally. During each of the subsequent 12 trials, subjects were presented with a fixation point before a 4-ms exposure of a suboptimal facial prime, immediately followed by a 1000-ms exposure of a pattern mask (ideograph). Subjects were then presented for 2000 ms with a slide of the prime on one side of the screen and a slide of a face previously never shown (the foil) on the opposite side of the screen. They were asked to indicate which of the two faces they thought was the prime. The faces used as the suboptimal primes were the same for all subjects. The affective valence and gender of the foil, however, were orthogonally varied. Half of the subjects made forced-choice discriminations between slides with the same affective valence (i.e., both smiling or both scowling), and half discriminated between slides with the opposite affective valence (i.e., one smiling and one scowling). Gender consistency was likewise varied such that half of the subjects were presented with primes and foils that were of the same gender (i.e., both male or both female), whereas the remainder chose between two faces of the opposite gender (i.e., male and female). As in the previous forced-choice tests of awareness, the prime and incorrect alternative were counterbalanced such that stimuli that served as the prime for half of the subjects served as the foil for the remaining half, and vice versa.

Sixteen subjects were randomly assigned to each of the following four groups according to the properties of the pairs of stimuli presented: affective polarity and gender matched, affective polarity matched and gender opposite, affective polarity opposite and gender matched, and affective polarity and gender both opposite.

Results

No significant effects were found for the gender of the subject, so therefore the analysis of mean differences excluded this factor. A two-way ANOVA was performed on the subjects' choice data. As shown in Table 3, the combined inconsistent or opposite affect group had a mean accuracy of 7.19, which was significantly better than the chance level of 6.0, $t(62) = 6.26$, $p < .001$. There was no such main effect for gender consistency. Nor did gender consistency interact with affective consistency. The data can be summarized as follows: Primes shown as briefly as 4 ms can allow subjects to discriminate between faces that differ in emotional polarity. Distinct faces that do not differ in affective polarity, even if they differ in such obvious ways as gender, cannot be accurately discriminated from one another if they are exposed for only 4 ms.

General Discussion and Conclusions

In the previous studies, cognitive judgments, either categorical or psychophysical, responded to primes only at an optimal level of awareness. Judgments of size, symmetry, and gender were unaffected by their respective suboptimal primes, even when the priming stimulus was a face. In stark contrast, faces expressing affect used as suboptimal primes in Studies 1 and 2 produced significant shifts in subjects' ratings of liking and good–bad judgments. Moreover, subjects in the final study were able to make forced-choice discriminations at a level greater than chance between a prime and a foil only when the two faces were opposite in affective valence, namely, smiling and scowling. Subjects were unable to accurately discriminate between faces that did not differ in emotional polarity, even if they differed on other obvious dimensions, such as gender. Taken together, these findings further support the affective primacy hypothesis, suggesting that emotional reactions can occur with minimal stimulation and that they can therefore precede and alter subsequent cognitions (Zajonc, 1980).

It is apparent that affect can be elicited without the participation of subjects' awareness. More interesting, however, is the

Table 3
Average Number Correct in Forced-Choice Test of Awareness Varying the Affect and Gender of the Foils

	Affect		
Condition	Consistent	Inconsistent	Average
Consistent	5.44	7.37	6.41
Inconsistent	5.50	7.00	6.25
Average	5.47	7.19	

fact that the nonconscious priming of affective reactions under certain conditions can be more successful than when it is with subjects' full awareness. What are the differences between conscious and nonconscious affect that might be relevant to our results? When affect is elicited at levels outside of conscious awareness, it is diffuse, and its origin and address are unspecified. So-called *free-floating anxiety* is a state in which the source and target are not accessible to the patient's awareness. The more an affective state is accompanied by cognitive correlates or appraisals, the clearer its origin and address. (They need not be correct, however, in the sense of corresponding to some objective reality.) The very fact that an address can be specified makes the affective reaction less likely to be displaced or diffused. Because of its diffuse quality, nonconscious affect can "spill over" onto unrelated stimuli. The participation of directed cognitive correlates may impose constraints by focusing affect onto specific targets, thus preventing its displacement. This is perhaps the reason why suboptimal affective priming produced significant shifts in judgments of novel target stimuli, whereas optimal affective priming did not.

The priming of nonevaluative responses, on the other hand, revealed a diametrically opposite pattern, with optimal primes resulting in significant shifts in judgment. This intriguing result can be explained by allowing that different forms of information can be processed with different degrees or perhaps even different forms of access to awareness. Within this supposition, the processing of affective information seems, at least within the constraints of the present experiments, to have an earlier access than the processing of information that is not affective in nature.

The present findings, then, are consistent with the theoretical model presented in Figures 2 and 3 and with the continuum of consciousness model proposed by Öhman et al. (1989) in which affect is processed early in the information-processing chain. At longer exposure durations it is possible that new information overwhelms this early subjectively felt affect. If the later information is congruent with affect in polarity, there is summation. Conversely, if the subsequent information is inconsistent with the initial affective reaction, there is dilution. The results of the secondary analyses carried out in Studies 1 and 2 that separated the primes according to attractiveness support this conjecture.

One could argue, however, that the present results could be explained within a cognitive mediation framework. Such a framework would suggest that priming is successful because it makes categories accessible (Bargh, 1982; Collins & Loftus, 1975; Higgins, Bargh, & Lombardi, 1985; Meyer & Schvaneveldt, 1971; Ratcliff & McKoon, 1988). If one views the results of Studies 1 and 2 in terms of cognitive mediation, one could surmise that the affective primes made the general categories of positive or negative objects and events more accessible. This interpretation would not conflict with the finding that affective priming is less effective at an optimal level if one further assumes that at a full level of exposure, not only are gross positive and negative categories and their associative nets activated, but many other categories are activated as well, such as gender, age, attractiveness, and so forth, perhaps overwhelming the more general affective reaction.

A strict cognitive mediation interpretation, however, would be hard-pressed to explain the failure to produce suboptimal priming effects for such simple categories as symmetry, size, and gender given the success of suboptimal affective priming under identical experimental conditions. The fact that only the suboptimal affective primes evoked a significant pattern of results suggests that the conceptualization of positive and negative affect as being equivalent to any other category is inadequate.

Neuroanatomical Evidence: Structures and Processes Allowing for Affective Primacy

The proposition that cognitive and affective processes, although continually interacting, are basically independent (Zajonc, 1980, 1984) has received convergent support in the form of recent neuroanatomical discoveries. For example, separation of affective processes on the one hand and recognition and categorization on the other is suggested in cases of prosopagnosia (PA). Many prosopagnosics are completely incapable of making even the most basic categorizations of faces, such as gender, race, and age (Bodamer, 1947; Pallis, 1955), although they retain their ability to make appropriate affective responses to distinct facial expressions (Ellis, 1986). In fact, PA patients, who suffer from bilateral cerebral lesions, are characterized by their inability to recognize the faces of persons with whom they are familiar. Interestingly, however, several studies have demonstrated that PA patients generate elevated skin conductance (galvanic skin response, or GSR) when presented with faces of persons they had previously known but cannot recognize (Bauer, 1984; Tranel & Damasio, 1985). As in the mere exposure phenomenon (Kunst-Wilson & Zajonc, 1980), prosopagnosics manifest a positive affective reaction to familiarity without the benefit of conscious recognition.

In interpreting these PA results, Bauer (1984) has proposed a model involving at least two anatomically and functionally distinct pathways. He has concluded that the prosopagnosics' bilateral lesions selectively impair the ventral visiolimbic pathway (implicated in object recognition) while sparing the dorsal visiolimbic connections. These spared visiolimbic connections allow for a preliminary, or "preattentive," analysis of emotional significance. In other words, prosopagnosics seem to retain their preferenda while losing their discriminanda (Zajonc, 1980).

Quite the opposite pattern is evident in patients suffering from prosopo-affective agnosia (PAA). PAA patients show deficits in discriminating specific emotions without suffering decrements in otherwise recognizing or categorizing faces in terms of their more "objective" properties. In a study by Kurucz and Feldmar (1979) PAA patients manifested no decrement in recognizing the photographed faces of both famous individuals and ward personnel. These same individuals, however, were severely impaired in their ability to discriminate between photographs of faces depicting happiness, anger, and sadness. Subjects' responses indicated that they failed to identify the appropriate emotion despite being able to perceive the features representative of the emotion. For example, typical PAA responses were "his face is wet, he is happy" or "he shows his teeth, he is sad" (Kurucz, Feldmar, & Werner, 1979, p. 94). The authors concluded that the ability to recognize faces is independent of the ability to process the affect conveyed by these faces. A similar dissociation between affect and cognition is seen following an amygadalectomy that results in psychic blindness, or the Klüver-Bucy syndrome. Klüver and Bucy (1937) discovered that following a bilateral anterior lobectomy monkeys cease being threatened by stimuli that were previously threatening. They begin to eat raw meat and other previously shunned foods and show severe disturbance in sexual behavior. Nevertheless, these animals can be trained to make consistent discriminations among unfamiliar stimuli on the basis of physical characteristics such as size, shape, and color. One might suggest that for these animals, as for the PAA patients, objects lose their preferenda while retaining their discriminanda.

Even more definitive evidence on the separation of affective and cognitive processes has been recently contributed by Zola-Morgan, Squire, Alvarez-Royo, and Clower (1991). These researchers conducted tests of emotional reaction and memory function on four groups of monkeys: intact monkeys, monkeys whose amygdala had been removed, monkeys whose hippocampus—a structure heavily implicated in cognitive functions (LeDoux, 1987)—had been removed, and monkeys whose amygdala and hippocampus had both been removed. Monkeys with amygadalectomies performed well on memory tasks but lost their emotional reactions to emotion-inducing stimuli. In contrast, damage to the hippocampal formation resulted in memory deficits while leaving the emotional processes intact. Monkeys with lesions in both the hippocampus and the amygdala lost both their emotional reactivity and their ability to retain newly learned discriminations. These data agree with the notion of affective–cognitive independence.

A final converging line of neuroanatomical research reveals data supporting not only affective–cognitive independence but also affective primacy (Zajonc, 1984, 1989). It has been the common view that after registering stimuli, the sensory apparatus sends signals to the thalamus, which in turn relays them to the sensory areas of the neocortex for integration and analysis of meaning. This view is consistent with cognitive appraisal theory (Lazarus, 1982), which would require that all emotional reactions be mediated by neocortical activity. Yet LeDoux and his colleagues (Iwata, LeDoux, Meeley, Arneric, & Reis, 1986; Iwata, Chida, & LeDoux, 1987; LeDoux, 1986, 1987, 1990; LeDoux, Iwata, Cicchetti, & Reis, 1988) have found a direct pathway between the thalamus and the amygdala that is just one synapse long. This direct access from the thalamus to the amygdala allows the amygdala to respond faster to a stimulus event than the hippocampus, the latter being separated from the thalamus by several synapses. According to LeDoux, the response in the amygdala can occur as much as 40 ms faster. This neuroanatomical architecture thus allows us to like something even without knowing what it is.

Concluding Remarks

For brevity, priming was sometimes referred to as either cognitive or affective, depending on the priming stimuli. For clarity, however, it must again be noted that whether we categorize a form of priming as *cognitive* or *affective* depends not only on the type of priming stimulus used but also on the responses that constitute the dependent measures. Given these distinctions, we should expect that affective priming may show different patterns, depending on the priming stimuli and on the primed responses. For example, if affective priming must be induced by a prior cognitive process (e.g., by the presentation of affect-laden adjectives), we might expect effects similar to those obtained in semantic priming with stronger effects at optimal exposures than at suboptimal exposures. In the case of the priming of cognitive categories, for example, the typical finding is that when degree of accessibility is varied, stimuli with easier access have greater influence. Tversky and Kahneman's (1974) notion of availability proposes just that. There is, however, the possibility that early access to certain aspects of the semantic content of a word exists (Fowler, Wolford, Slade, & Tassinary, 1981; Marcel, 1983). If so, and if we assume that the dominant semantic factor of words is the evaluative factor that accounts for over 50% of the variance in meaning (Osgood, 1957), then longer exposures might result in dilution of the initial affect as seen in Studies 1 and 2. Of course, empirical evidence is required to verify this conjecture, and Studies 1 and 2 could be replicated using words as primes.

It is also necessary to explore whether affective stimuli other than faces, which may have very unique properties, replicate the present pattern of results. For example, would slides of snakes change preferences for Chinese ideographs only when presented suboptimally?

The present research raises other important theoretical questions. For instance, what are the implications of affective primacy on memory? How might the present results be integrated with current work on implicit memory (Roediger, 1990), indirect memory (Merikle & Reingold, 1991; Richardson-Klavehn & Bjork, 1988), repetition priming (Tulving & Schacter, 1990), and perceptual fluency (Jacoby & Dallas, 1981; Mandler, 1980)? The common feature of these extensive lines of research on memory is that by means of subtle tests they reveal memories of which the subject may not be aware. If subjects show preference for a stimulus that was preceded by a suboptimal prime of which they were not aware, can the expression of preference be considered simply as a more subtle indicator of memory (Merikle & Reingold, 1991)? Or could this be a distinct process, namely, affect? The present findings seem to support the second possibility. The diametrically opposite patterns of results we obtained did not depend on whether the tests were direct or indirect; they were all indirect. They depended only on whether the prime contained affective elements.[7]

[7] Interestingly, a reanalysis of our data from Study 1 and Study 2 shows that suboptimal affective primes had their most pronounced effect on the initial presentation of each of the 10 key ideographs. In other words, if a subject was first presented with an ideograph preceded by a positive prime (a smiling face), then the subsequent pairing of the same ideograph and a negative prime (a scowling face) was less effective. Consequently, the present experimental paradigm in which the identical ideographs were repeated twice may have had the inadvertant effect of dampening the overall magnitude of the priming. This pattern may have been due to subjects' becoming less susceptible to the suboptimal primes as the experiment wore on. However, this attenuation of effectiveness for subsequent priming might also suggest that subjects may possess some sort of residual memory trace of the individual ideographs that includes their initial affective evaluation. Importantly, no similar patterns emerged between the first and second presentations of the nonaffective primes in Studies 3–5. Coupled with other demonstrations of the subliminal memory traces of affective primes (Krosnick, Betz, Jussim, & Lynn, 1992) these findings provide indirect support for the

Another unanswered question involves the point of contact between early affective reactions and more specific emotions, such as anger or fear. Is it the case that greater emotional specificity is possible without the participation of cognitive processes? Would the subject attribute anger to Chinese ideographs preceded by an angry suboptimally presented face and fear to those preceded by a fearful face? Or would both angry and fearful suboptimal primes result in a gross negative affective reaction? A recent study (Murphy, 1990) examined subjects' ability to discriminate among six specific facial expressions (Ekman, 1972) at suboptimal levels of exposure. Subjects were only able to differentiate among emotions that differed in hedonic polarity. Happiness could be discriminated at a better-than-chance level from the negative emotions of anger, fear, disgust, and sadness. No reliable differentiation was observed among the four negative emotions. Also, surprise was not distinguished from any of the emotions, positive or negative. These findings suggest that the kinds of affective reactions we were able to induce with suboptimal stimulus input in Studies 1 and 2 may be limited to gross positive and negative influences. This implies that for more differentiated emotions, such as fear or anger, to emerge some sort of cognitive appraisal may be necessary.

Future research in this domain will, it is hoped, lead to a more systematic understanding of the dynamics of the interaction between affect and cognition. Above all, the methods presented here—namely, the comparisons between the effects of optimal and suboptimal primes—might stimulate future explorations of the degree to which cognitive processes available to consciousness participate in affective reactions and, conversely, how affective reactions of which the individual is not aware can modify perceptual and cognitive processes. However, there is clearly less doubt now that affective reactions may precede cognitive processes and may occur without conscious access to their eliciting stimuli.

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early processing of affective information and point toward the relationship between information presented outside conscious awareness and memory as an intriguing arena for future inquiry.

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