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Affective Habituation: Subliminal Exposure to Extreme Stimuli Decreases Their Extremity

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Following a functional perspective on evaluation, the authors hypothesized that subliminal exposure to extreme stimuli (e.g., extremely negative or positive words) would lead these stimuli to be perceived as less extreme. This process—affective habituation—was tested in 4 experiments. In Experiment 1, participants were subliminally exposed to extremely positive and extremely negative words. In a subsequent explicit-judgment task, these words were rated as less extreme than extreme words that had not been presented. In Experiment 2, these results were replicated with an implicit evaluation measure. In Experiments 3 and 4, subliminal exposure to extreme positive and negative words made the words "behave" as words that are only moderately positive or negative. Several implications are discussed.

The capacity to quickly classify perceived stimuli either as "positive" and "hospitable" or as "negative" and "threatening" is one of the most vital psychological abilities. In the past 25 years, many theorists and researchers have investigated the psychological processes underlying this ability (Bargh, Chaiken, Govender, & Pratto, 1992; Cacioppo, Priester, & Berntson, 1993; Damasio, 1994; Davidson, 1992, 1994; Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Frijda, 1986; Gray, 1987; Hunt & Campbell, 1997; Lang, 1995; LeDoux, 1996; Öhman & Soares, 1994; Shizgal, 1998; Zajonc, 1980). The importance of the speed with which humans and other animals evaluate positive and negative stimuli follows from its direct relation to our chances for survival. As LeDoux noted, there are two categories of organisms: "the quick and the dead" (p. 163).

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By now, we know much about how the system (or systems) responsible for evaluation is shaped. First, as alluded to above, the system is fast. Ironically, we know whether a stimulus is positive or negative before we know exactly what it is. That is, we evaluate stimuli before we have conscious access to their meaning (e.g., Bargh, Litt, Pratto, & Spielman, 1989; Dijksterhuis & Aarts, in press; Greenwald, Klinger, & Liu, 1989; Murphy & Zajonc, 1993; Öhman & Soares, 1994, 1998; Shevrin, 1992; Zajonc, 1980). Second, although the intensity with which the affective system reacts differs as a function of extremity of the perceived stimuli (Fazio et al., 1986), *all* stimuli are evaluated (Bargh, et al., 1992; Bargh, Chaiken, Raymond, & Hymes, 1996; but see Fazio et al., 1986). Third, evaluation is automatic in that it does not require the intention to make an evaluative judgment (Hermans, De Houwer, & Eelen, 1994). We evaluate all incoming stimuli, whether we want to or not.

Although in a broader sense the function of (quick) evaluation is survival, its more specific function is signaling. It signals that something wrong or that something right is going on. This signal is experienced as arousal and is the consequence of immediate metabolic and neural changes following the perception of a stimulus (Lang, 1995; LeDoux, 1996; Sapolsky, 1998). These changes, in turn, put other processes in motion (Cacioppo, Gardner, & Berntson, 1999; Gray, 1987; Shizgal, 1998). The signal orients the organism toward the stimulus so that cognitive processes can scrutinize it ("What exactly is it?") and

steers motivational–behavioral systems to take appropriate action (approach or withdrawal).

More important, the evaluative system not only categorizes stimuli as simply "good" or "bad." By varying the intensity with which it reacts to stimuli, it also signals how negative or how positive a stimulus is. Fazio et al. (1986; see also Fazio, 1993, 2001) showed that extreme negative or extreme positive stimuli have a more pronounced impact on the evaluative system than stimuli that are merely moderately positive or negative. That is, the evaluative system reacts with greater intensity to extreme stimuli.

Another important aspect of the evaluative system is that it is essentially subjective. As Cacioppo et al. (1999) noted, "one distinction between the evaluative channels of the affect system and the perceptual channels of the perceptual system is that the former is constructed not to return objective properties of the stimulus but to provide a subjective estimate of the current significance of these properties" (p. 840). In this regard, Shizgal (1998) compared the output of the evaluative system with subjective reactions to hot or cool stimuli (Cabanac, 1971). A cool stimulus can be refreshing when one is overheated, but uncomfortable when one is cold already. In addition, Cacioppo and colleagues (Cacioppo, Crites, Berntson & Coles, 1993; Cacioppo, Crites, Gardner, & Berntson, 1994) demonstrated that stimuli that are subjectively more extreme because of contextual manipulations (such as a negative stimulus in a set of positive context stimuli) evoke a larger late positive potential of the event-related brain potential than stimuli that were not made subjectively extreme. Thus, the intensity of the evaluative system's reaction not only depends on the objective properties of the stimulus, but also on subjective, contextual variables.

Affective Habituation

The fact that the intensity with which the evaluative system responds varies, in combination with the notion that the reaction of the evaluative system is subjective, leads to an intriguing empirical question: What happens if we encounter the same extreme stimulus repeatedly in a short period of time? If the evaluative system were purely objective, it might react with the same vigor and intensity each time the stimulus was perceived. However, as some researchers have stated (Cacioppo et al., 1999; Shizgal, 1998), this is not how the evaluative system was designed. Instead, it is likely that the intensity of the reaction of the evaluative system would decrease after multiple exposures to the same extreme stimulus. In other words, a process of *affective habituation* would ensue.

There are various reasons to propose such a process. First, there is some evidence that repeated exposure does lead to less intense physiological reactions to emotionally laden stimuli. Electrodermal responses diminish rapidly after repeated stimulus exposure (e.g., Klorman, 1974). Furthermore, Bradley, Lang, and Cuthbert (1993) demonstrated that repeated exposure to emotional pictures elicits startle reflex habituation. They showed patterns of habituation for blink magnitude, skin conductance, and facial corrugator electromyographic (EMG) responses. Moreover, Wright et al. (2001) recently obtained neurophysiological evidence for affective habituation. They presented participants with photos of various facial expressions, and repeated exposures led to a significant functional magnetic resonance imaging signal decrement in the left dorsolateral prefrontal and premotor cortex as well as in the right amygdala. In sum, there is evidence for habituation to affective stimuli on a (neuro) physiological level.

A second reason follows directly from the inherent function of the evaluative system. As stated previously, the evaluative system functions to signal potential benefits or potential dangers. Now, a signal only needs to be given once (provided it is picked up, of course). A police officer witnessing someone trying to break into a house needs to signal and categorize this behavior only once ("Burglary!"). After the signal has been given, other (cognitive and behavioral) responses are called for ("How can I catch this thief?"). The evaluative system is likely to operate in the same fashion. When a person encounters a snake while taking a walk in the woods, the evaluative system only needs to signal the danger once. After that, other psychological processes should be elicited. Cognitive elaboration may take place ("Is this a poisonous snake?") as well as behavioral responses, such as a careful and slow retreat.

A third and related reason for why affective habituation may occur is that it *may actually be dysfunctional not to habituate*. If we encounter a very positive or very negative stimulus, the evaluative system will react intensely. If the evaluative system continued to react with the same intensity to the stimulus for the entire period during which it is perceived, appropriate action would be impossible. Reactions to extreme stimuli often follow the same pattern. As LeDoux (1996) noted, in the face of danger "it is quite common to observe startle, orienting, then freezing or fleeing or attack" (p. 132). If the reaction of the evalu-

ative system did not decrease in intensity, we would be trapped in being overwhelmed by extreme stimuli. In other words, a continued, strong reaction of this system would interfere with appropriate cognitive and behavioral responses. And although this occasionally happens, such as with prolonged panic reactions, we know that we are usually able to deal with extreme stimuli quite well.

Our goal was to investigate the process of affective habituation. Our aim was to test two hypotheses. Our first hypothesis follows directly from the evidence discussed earlier showing diminished physiological reactions on repeatedly presented emotional stimuli. If the intensity with which the evaluative system responds decreases when we are exposed to the same extreme stimulus repeatedly, we can predict that this stimulus then becomes subjectively less extreme. In concrete terms, if we are exposed to an extremely positive or an extremely negative stimulus, our evaluative system reacts with great intensity and we perceive the stimulus to be extreme. However, if we are presented with this same stimulus a few more times, the intensity with which the evaluative system reacts decreases. As a result, we perceive the stimulus to be less extreme. Our first hypothesis, then, is that repeated exposure to an extreme stimulus makes this stimulus *subjectively less extreme.*

A second hypothesis is that affective habituation also occurs when a stimulus is presented subliminally. Conscious awareness of a stimulus is not necessary for it to elicit an affective reaction (e.g., Bargh et al., 1989; Dijksterhuis & Aarts, in press; Greenwald et al., 1989; Murphy & Zajonc, 1993; Öhman & Soares, 1994, 1998; Shevrin, 1992). That is, stimuli that are presented subliminally also elicit a response from the evaluative system. This means that subliminally presented stimuli should, in principle, also be prone to affective habituation. An additional benefit of investigating affective habituation this way is that subliminal exposure is a psychologically, very "clean" way of exposure. Very brief exposures are enough for the evaluative system to react, while preventing other, hypothesis-irrelevant processes (such as those that may follow conscious recognition) from being evoked.

Overview

Experiments 1 and 2 were designed as direct tests of our hypotheses. Participants were exposed to extreme positive and negative words for very brief durations, thereby preventing conscious recognition of the stimuli. We presented participants with six different extreme positive words and six different extreme negative words, six times each. Experiments 1 and 2 only differed in the assessment of subjective extremity. Whereas in Experiment 1 participants explicitly judged the words, in Experiment 2, an implicit measure with response latencies was used. In both experiments, the subjective extremity of the presented words was compared with the subjective extremity of words not previously presented.

Experiments 3 and 4 were designed to demonstrate that previously presented extreme stimuli start to "behave" as moderate stimuli. When a target stimulus is primed with a positive or negative stimulus, this priming stimulus affects the reaction to the target stimulus (e.g., Bargh et al., 1992; Fazio et al., 1986; see Fazio, 2001, for a recent review). For instance, when participants have to judge as quickly as possible whether the word *love* is positive or negative, participants are faster when presentation of the word *love* is preceded by presentation of another positive word. In such cases, assimilation occurs. However, Glaser and Banaji (1999; see also Herr, 1986; Stapel, Koomen, & van der Pligt, 1996) demonstrated that if the prime word is very extreme (rather than moderate), contrast may ensue. That is, participants are slower to judge that the word *love* is positive when this word is preceded by an extremely positive word. Experiment 3 was designed to replicate these effects of assimilation with moderate primes and contrast with extreme primes. Experiment 4 was designed to show that earlier exposure to extreme stimuli causes these stimuli to behave as moderate stimuli, or as stimuli that, in line with our hypothesis, have become subjectively less extreme. Here, we compared priming with two types of stimuli: extreme words that had been presented previously, and extreme words that had not been presented. In the first case, we expected assimilation to occur, whereas in the latter case we expected contrast.

Experiment 1: Method

Participants

Thirty-seven undergraduate students of the University of Amsterdam participated in the experiment. In return, they received either course credits or 10 Dutch guilders (Dfl.), depending on their preference.

Procedure and Materials

Upon entering the laboratory, participants were seated in individual cubicles in front of a computer.

The experimenter started the computer program and left the cubicle. All instructions were given via the computer. In the first task, participants were presented with the extreme negative and extreme positive words. The extreme words were selected on the basis of a pilot study in which 35 undergraduate students judged the valence of 151 short, medium-frequency Dutch words on a 9-point scale ranging from 1 (*extremely negative*) to 9 (*extremely positive*). The 12 most extreme positive words (Ms > 7.8) as well as the 12 most extreme negative words (Ms < 2.3) were chosen as targets for the experiment. The positive words were *zon* (sun), *lief* (sweet), *zomer* (summer), *strand* (beach), *katje* (kitten), *baby* (baby), *vriend* (friend), *vrij* (free), *zacht* (soft), *lach* (smile), *lente* (spring), and *geluk* (happiness). The negative words were *bom* (bomb), *dood* (dead), *gemeen* (mean), *haai* (shark), *oorlog* (war), *wapen* (weapon), *kanker* (cancer), *angst* (fear), *dief* (thief), *slang* (snake), *hel* (hell), and *coma* (coma).

We divided the 12 selected positive words and the 12 selected negative words into two sets of six positive and six negative words. The computer program randomly assigned participants to be given one of the two sets.

The words were presented as follows; Participants saw a random letter string ("noahlief") in the center of the screen for 200 ms. Subsequently, an extreme positive or an extreme negative word was presented for 8.5 ms, immediately masked by a row of xs ("xxxxxxxx"). This row remained on the screen for 500 ms. All stimuli were presented in 14-point Chicago font. After the row disappeared, participants were asked to indicate whether the letter string started with a vowel or with a consonant by pressing one of two keys on the keyboard. After 1 s, the next random letter string appeared. The six positive words and six negative words were presented six times each, in random order, for a total of 72 trials.

After exposure to the words, participants were asked to judge the valence of 24 words. These words consisted of the set of six positive words and the six negative words that had been previously presented, as well as the other set of six positive and six negative words that had not been presented. Participants indicated their answer on a 21-point scale ranging from −10 (*extremely negative*) to +10 (*extremely positive*). The 24 words were presented in random order.

After completion of the task, an awareness check was administered. When asked, none of the participants indicated they had seen any words in the first task. Subsequently, participants were asked to return to the experimenter, where they were thanked, debriefed, and dismissed.

Results and Discussion

First, the judgments of the negative words were recoded so that all resulting scores were positive (−1 became 1, −2 became 2, etc.), and for both positive and negative words, a higher score indicated greater perceived extremity. The judgments of the words were then subjected to a 2 (set: 1 vs. 2) × 2 (valence: positive vs. negative) × 2 (previous exposure: yes vs. no) analysis of variance (ANOVA). The only significant effect was the predicted main effect of previous exposure, $F(1, 25) = 6.00$ $p < .02$. The (nonrecoded) means and standard deviations are given in Table 1. As can be seen, words that participants were previously exposed to were evaluated as less extreme than words participants had not been exposed to. In sum, our expectations based on the affective habituation hypothesis were confirmed.

Experiment 2 was designed to replicate the results of Experiment 1. However, in Experiment 2, we measured perceived extremity on an implicit measure.

Experiment 2: Method

Participants

Sixteen undergraduate students of the University of Amsterdam participated in the experiment. In return, they received either course credits or Dfl. 10, depending on their preference.

Procedure and Materials

Upon entering the laboratory, participants were seated in individual cubicles in front of a computer. The experimenter started the computer program and left the cubicle. All instructions were given via the computer. The task with which participants were ex-

Table 1
Mean Evaluation of Extreme Positive and Extreme Negative Words as a Function of Previous Exposure

	Mean		Standard deviation	
Variable	Exposed	Not exposed	Exposed	Not exposed
Positive words	6.15	6.62	2.08	1.90
Negative words	−6.49	−6.65	1.54	1.65

Note. Evaluation based on a scale ranging from −10 (*extremely negative*) to +10 (*extremely positive*).

posed to the extreme words was the same as in Experiment 1.

In Experiment 2, the dependent measure was based on the well-documented Implicit Association Test (IAT; Greenwald & Farnham, 2000; Greenwald, McGhee, & Schwartz, 1998). Our task comprised three stages. In the first stage, participants were presented with the words *good* and *bad* on the computer screen. Both words appeared 12 times in random order. Participants pressed one key (the "A" key, colored green) on the keyboard whenever *good* appeared, and another key (the "6" key on the right side of the keyboard, colored red) whenever the word *bad* appeared. The word disappeared after the key press, and then, after 1 s, the next word appeared. In a second stage, participants were presented with 12 positive and 12 negative words. These words were not part of the sets critical for the experiment. Whenever participants saw a positive word, they pressed the green button, and whenever they saw a negative word, they pressed the red button. The third stage was the critical stage. Here, participants were presented with the word *good* 12 times and with the word *bad* 12 times. In addition, they were presented with 12 positive words and 12 negative words. This included the set of the six positive and six negative words that had been previously presented, as well as six positive and six negative words that had not been presented. Participants pressed the green key whenever they saw the word *good* or any other positive word, and they pressed the red key whenever they saw the word *bad* or any other negative word. More important, during all stages, participants were asked to respond as fast and as accurately as possible.

Our hypothesis is based on the principles governing the IAT (see Greenwald et al., 1998). During the third stage, the green key represents a positive stimulus because when participants see the word *good,* they press this green key. Conversely, the red key represents a negative stimulus because when participants see the word *bad,* they press the red key. The instructions for the target words are the same: Participants press the green key when they see a positive target word and the red key when they see a negative target word. Now, the more unambiguously positive or negative a word is, the faster the response should be. That is, more negativity of the target words should lead to a faster response with the red key, while more positivity should lead to a faster response with the green key. In general, more extremity should lead to faster responses in this task.

After completion of the task, an awareness check was administered. Again, none of the participants indicated they had seen any words in the first task. Participants were then asked to return to the experimenter, where they were thanked, debriefed, and dismissed.

Results and Discussion

First, response latencies to the incorrect responses were omitted. Subsequently, all response latencies to the positive and negative words from the third stage were subjected to a 2 (set: 1 vs. 2) × 2 (valence: positive vs. negative) × 2 (previous exposure: yes vs. no) ANOVA. Two main effects appeared. First, a main effect was obtained for valence, $F(1, 15) = 8.01$, $p < .02$. Positive words were responded to faster than negative words. More relevant to our hypothesis, the main effect of previous exposure was also reliable, $F(1, 15) = 6.90$, $p < .02$. The means and standard deviations are given in Table 2. As can be seen, the results of Experiment 1 were replicated: Participants responded faster to words that had not been presented than to words that had been previously presented. Thus, the latter category of words was treated as less extreme. Again, our expectations based on the affective habituation hypothesis were confirmed.

Experiment 3

The first two experiments yielded evidence for the affective habituation hypothesis. Some interesting questions are: What exactly happened to the stimuli that were repeatedly presented? To what extent did they become subjectively less extreme? Was the loss of subjective extremity of such magnitude that the stimuli became only moderately negative or moderately positive? Experiments 3 and 4 were designed to test these intriguing possibilities.

As discussed in the introduction, extreme and moderate stimuli can have markedly different effects on the processing of immediately subsequent stimuli

Table 2
Mean Response Times (in Milliseconds) to Extreme Positive and Extreme Negative Words as a Function of Previous Exposure

	Mean		Standard deviation	
Variable	Exposed	Not exposed	Exposed	Not exposed
Positive words	707	685	71	76
Negative words	774	722	65	59

Note. Higher response times represent less extremity.

(Glaser & Banaji, 1999; Herr, 1986; Stapel et al., 1996; see also Dijksterhuis et al., 1998). Glaser and Banaji (1999) conducted a series of experiments with unambiguous results: moderate stimuli have assimilative effects on stimuli subsequently processed, while extreme stimuli have contrastive effects. Given that extreme stimuli lose some of their subjective extremity after multiple exposures, as demonstrated in the first two experiments, they may start to behave as moderate stimuli. That is, although extreme stimuli lead to contrast under normal circumstances, they could lead to assimilation after multiple exposures.

In Experiment 3, we sought to conceptually replicate the effects of Glaser and Banaji (1999). Participants were shown a photo of a young woman six times, and presentation of the picture was preceded by various words. These words were all either extremely negative, extremely positive, moderately negative, or moderately positive. Later, participants were asked to evaluate the stimulus person. When the stimulus person was paired with moderate stimuli, assimilation was expected to occur: a stimulus person paired with positive words should be evaluated more favorably than a stimulus person paired with negative words. Conversely, when the stimulus person was paired with extreme words, contrast was expected: pairing with positive words should lead to a more negative evaluation than pairing with negative words.

Method

Participants and Design

Seventy-five undergraduate students were randomly allocated to the cells of a 2 (valence: positive vs. negative) × 2 (extremity: extreme vs. moderate) between-subjects design. For their participation, they received either course credits or Dfl. 10, depending on their preference.

Procedure and Materials

Upon entering the laboratory, each participant was brought to an individual cubicle and seated in front of a computer. The experimenter started the computer program and left the cubicle. All instructions were given via the computer program. Participants were told that the experimenter was interested in how quickly people can make simple decisions under distracting circumstances. Participants would be exposed to random letter strings for brief periods of time, each followed by the presentation of a photograph of a person. After presentation of the photograph, participants would indicate as fast as possible whether the random letter string started with a vowel or with a consonant.

First, participants were presented with a random letter string for 200 ms. Subsequently, a word was presented for 8.5 ms and immediately masked by a photo. This photo remained on the screen for 2 s, after which participants indicated whether the letter string started with a vowel or a consonant by pressing one of two keys. After a delay of 1.5 s, the next random letter string appeared. Participants were presented with six such trials.

In these six trials, participants were presented with six different words. Depending on the condition, these words were all either extremely negative, extremely positive, moderately negative, or moderately positive. The extreme words were selected from the sets used in Experiments 1 and 2. The positive words were *zon* (sun), *zomer* (summer), *strand* (beach), *vriend* (friend), *lief* (sweet), and *vrij* (free). The negative words were *dood* (dead), *haai* (shark), *oorlog* (war), *wapen* (weapon), *kanker* (cancer), and *angst* (fear). The moderate words were chosen on the basis of the pilot study discussed in the *Method* section of Experiment 1. The positive words were *appel* (apple), *aap* (monkey), *honing* (honey), *oogst* (harvest), *palm* (palm tree), and *stad* (city; *M*s = 6.6–7.2). The negative words were *afwas* (dirty dishes), *deuk* (dent), *kaal* (bald), *leger* (army), *nat* (wet), and *zuur* (sour; *M*s = 2.9–3.4).

Two different photographs of young, moderately attractive women from an American college yearbook were used for the experiment. The computer program randomly assigned participants to one of the two photographs.

After participants finished this task, they were asked to evaluate the woman in the photo they had seen. We told them that "it is hard to judge people just on the basis of their appearance, but we would still like to know your impression of this person." Participants were asked to answer two questions on 7-point scales: "Do you like the person?" (1 = *not at all,* 7 = *very much*), and "How positive or negative is your impression of the person?" (1 = *very negative,* 7 = *very positive*). As expected, the answers to the two questions correlated highly ($r = .69$, $p < .0001$), so they were collapsed into a single measure of evaluation.

After completion of the task, an awareness check was administered. None of the participants indicated they had seen any words before the presentation of the photographs. Participants were then asked to return to

the experimenter, where they were thanked, debriefed, and dismissed.

Results and Discussion

The mean of the answers to the two evaluation questions was subjected to a 2 (valence: positive vs. negative) × 2 (extremity: extreme vs. moderate) × 2 (stimulus person: 1 vs. 2) between-subjects ANOVA. The only significant effect was the predicted Valence × Extremity two-way interaction, $F(1, 70) = 6.17$, $p < .02$. The means are listed in Table 3. When the stimulus person was paired with moderate words, assimilation occurred: The person was evaluated more positively after being paired with positive stimuli than after being paired with negative stimuli. However, when the words were extreme, contrast occurred: The person was evaluated less positively after being paired with positive stimuli than after being paired with negative stimuli. These results constitute a conceptual replication of Glaser and Banaji (1999).

Experiment 4 was designed to replicate the effects of Experiment 3. However, the two moderate-word conditions were replaced by a condition in which the person was paired with extreme words that had been previously presented.

Experiment 4: Method

Participants

Thirty-three undergraduate students of the University of Amsterdam participated in the experiment. In return, they received either course credits or Dfl. 10, depending on their preference.

Procedure and Materials

Upon entering the laboratory, participants were seated in individual cubicles in front of a computer. The experimenter started the computer program and left the cubicle. All instructions were given via the computer. The task in which participants were exposed to the extreme positive and negative words was the same as in Experiments 1 and 2. We again used two sets of words (as in Experiment 1). The computer program randomly assigned people to one of the sets.

Table 3
Mean Evaluation of the Stimulus Person as a Function of Valence of the Paired Words (Positive vs. Negative) and Extremity of the Paired Words (Extreme vs. Moderate)

	Mean		Standard deviation	
Variable	Moderate	Extreme	Moderate	Extreme
Positive	4.21	3.92	0.69	0.69
Negative	3.93	4.40	0.71	0.52

Note. Higher scores represent more positive evaluations.

Only half the participants were exposed to the positive and negative words that would later be used during the second stage of the experiment. The remaining participants performed the same task but were exposed to extreme words that would not be used during the second stage. The same two sets of words were used during the second stage of the experiment, and participants were again randomly assigned to one of the sets for this stage. Hence, some participants received the same set in both stages (the previous exposure condition), while others received different sets (the nonexposure condition).

The second stage, during which a stimulus person was paired with words, was similar to Experiment 3. Although participants in Experiment 3 were only presented with one picture, the participants in Experiment 4 were presented with both pictures. Thus, all participants saw two pictures, both presented six times in random order. One picture was only paired with negative words, while the other was only paired with positive words. Allocation of words to pictures was counterbalanced.

After participants finished this task, they were asked to evaluate both stimulus persons. The order in which they evaluated the stimulus persons was randomized. As in Experiment 3, we told participants that "it is hard to judge people just on the basis of their appearance, but we would still like to know your impression of this person." Participants were asked to answer two questions on 7-point scales: "Do you like the person?" and "How positive or negative is your impression of the person?" As expected, the answers to the two questions correlated highly ($r = .65$, $p < .01$), so they were collapsed into a single measure of evaluation.

For exploratory reasons, we asked participants to make some additional judgments. First, we asked them to judge both women on attractiveness on a 7-point scale. Second, we asked participants to judge the women on three trait dimensions: intelligence, honesty, and sense of humor. Again, participants indicated their responses on 7-point scales. Finally, we asked participants if they had to choose, which of the two women would they choose to hang out with. We again presented the two photographs and asked participants to indicate their answer by pressing one of two keys.

After completion of the task, an awareness check

was administered. Again, none of the participants indicated they had seen any words before the presentation of the photographs. Participants were then asked to return to the experimenter, where they were thanked, debriefed, and dismissed.

Results and Discussion

General Evaluation

The mean of the answers to the first two evaluation questions was subjected to a 2 (valence: positive vs. negative) × 2 (previous exposure: yes vs. no) × 2 (stimulus person: 1 vs. 2) between-subjects ANOVA.[1] The only significant effect was the predicted Valence × Previous Exposure interaction, $F(1, 31) = 5.78$, $p < .02$. The means are listed in Table 4. When the stimulus person was paired with extreme words that had been previously presented, assimilation occurred: The person was evaluated more positively after being paired with positive stimuli than after being paired with negative stimuli. However, when participants were not first exposed to the extreme words, a contrast effect appeared: The person was evaluated less positively after being paired with positive stimuli than after being paired with negative stimuli.

Attractiveness

The attractiveness scores were subjected to a 2 (valence) × 2 (previous exposure) × 2 (stimulus person) between-subjects ANOVA. The only significant effect was the predicted Valence × Exposure interaction, $F(1, 31) = 4.20$, $p < .05$. The means are listed in Table 5. As can be seen, the pattern reflects that of the general evaluation scores.

Trait Dimensions

The scores on the three trait dimensions were subjected to three 2 (valence) × 2 (previous exposure) × 2 (stimulus person) between-subjects ANOVAs. Although the general pattern of the trait scores was in the predicted direction, none of the effects reached conventional levels of significance (Fs < 1.56).

Table 4
Mean Evaluation of the Stimulus Person as a Function of Valence of the Paired Words (Positive vs. Negative) and Previous Exposure

	Mean		Standard deviation	
Variable	Exposed	Not exposed	Exposed	Not exposed
Positive	4.41	4.06	0.85	0.87
Negative	3.79	4.34	0.79	0.51

Note. Higher scores represent more positive evaluations.

Table 5
Mean Perceived Attractiveness of the Stimulus Person as a Function of Valence of the Paired Words (Positive vs. Negative) and Previous Exposure

	Mean		Standard deviation	
Variable	Exposed	Not exposed	Exposed	Not exposed
Positive	3.88	3.31	0.99	1.08
Negative	3.41	3.75	1.22	1.00

Note. Higher scores represent more perceived attractiveness.

Hanging Out

Under conditions of previous exposure, the expected assimilation effects appeared. Of the group of participants, 70.6% chose the woman paired with positive words over the woman paired with negative words. Conversely, a contrast effect was revealed under conditions without prior exposure: only 37.5% of the participants chose to hang out with the person paired with positive words. A chi-square test confirmed that the difference between conditions was significant, $\chi^2(33) = 11.60$, $p < .01$.

To summarize, the results of Experiment 4 replicate those of Experiment 3. Extreme stimuli lead to judgmental contrast, while moderate stimuli lead to assimilation. Experiment 4 shows that extreme stimuli start to behave as moderate stimuli after repeated exposure, thereby confirming our affective habituation hypothesis.

General Discussion

We proposed that when people repeatedly encounter extreme stimuli (either extremely positive or extremely negative), the intensity with which the evaluative system reacts to these stimuli decreases. Our idea was based on both logical and functional reasoning, as well as on previous research. First, an intense reaction of the evaluative system to an extreme stimulus functions as a signal: it tells the organism that something wrong or something right is going on. Once such a signal is given, it is not necessary for it to be given over and over again, and hence the affec-

[1] In separate analyses, we first established that none of the effects of order manipulations were significant (all Fs < 1).

tive system does not have to continue to give intense responses to the perception of the stimulus. Second, prolonged intense reactions of the affective system can actually be dysfunctional. Once an extreme stimulus is detected, other (cognitive and behavioral) processes should be instigated to deal with the stimulus in an appropriate fashion. Extreme affective responding can interfere with such processes.

We hypothesized that affective habituation would lead extreme stimuli to be perceived as less extreme after multiple exposures, even when these stimuli had been presented subliminally. Because the affective system responds with decreased intensity after repeated exposure to an extreme stimulus, the stimulus should subjectively be seen as less extreme. This hypothesis was tested in four experiments. In Experiments 1 and 2, participants were subliminally exposed to extreme positive and extreme negative words. Compared with extreme words that had not been presented, these words were later perceived to be less extreme. This effect was found with both an explicit evaluation task (Experiment 1) and an implicit evaluation task (Experiment 2).

Experiments 3 and 4 were designed to tackle an additional issue. Given that repeated exposure makes extreme stimuli less extreme, the question arises as to what extent they become less extreme? We hypothesized that extreme stimuli may actually start to behave as stimuli that are merely moderately positive or moderately negative. In Experiment 3, we replicated an effect obtained earlier by Glaser and Banaji (1999): a stimulus primed by a moderate stimulus led to assimilation, while a stimulus primed by an extreme stimulus led to contrast. In Experiment 4, repeatedly exposed extreme stimuli behaved like moderate stimuli. In an affective priming paradigm, these stimuli led to assimilation, not to contrast.

Which Stimuli Are Prone to Affective Habituation?

An interesting matter is whether a stimulus does need to be extreme rather than moderate for affective habituation to occur. Of course, one cannot make a categorical distinction between extreme and moderate stimuli. Rather, a continuum exists, ranging from, say, *very extreme* to *almost neutral.* The magnitude of affective habituation (i.e., the magnitude with which affective reactions decrease in intensity during repeated exposure) may be a direct function of this continuum: the more extreme a stimulus, the more pronounced the decrease in intensity will be. With less extreme stimuli, there is less need for affective reactions to decrease in intensity. After all, strong reactions interfere with subsequent psychological processes needed to effectively deal with an extreme stimulus. Given that a weak reaction interferes much less with this processing than a strong reaction, there is less need for habituation in the former case than in the latter. Furthermore, with less extreme stimuli, there is also less room for affective reactions to decrease in intensity. A reaction that is already very mild cannot decrease much further.

A second question is why affective habituation occured for both positive and negative stimuli? One could argue that negative stimuli should lead to greater affective habituation than positive stimuli because negative stimuli are more likely to lead to such intense affective reactions. After all, negative stimuli often grab more attention than positive stimuli (e.g., Pratto & John, 1991) and tend to have a greater influence on judgments (e.g., Cacioppo & Gardner, 1999). However, extreme positive stimuli can evoke high levels of arousal as well (e.g., Bradley, Codispoti, Cuthbert, & Lang, 2001; Lang, 1995). Just think about running into a secret love for the first time in months. Such a stimulus can certainly interfere with other psychological processes. Hence, our functional argument dictates a need for affective habituation to extreme positive stimuli. Nevertheless, if the strongest habituation effects occur for stimuli that lead to the most extreme initial affective reactions, they will probably be observed for stimuli that are direct threats to survival. In other words, though both positive and negative stimuli may be extreme enough to lead to affective habituation, the most extreme stimuli may all be negative.

Our data also do not suggest that affective habituation affects positive and negative stimuli differentially. We never obtained reliable interactions that indicated an asymmetry. Even a closer look at cell means does not reveal such asymmetries. In Experiment 1, the effect of affective habituation was more pronounced for positive than for negative stimuli, while the reverse was true in Experiment 2. The cell means in Experiments 3 and 4 indicate effects of comparable magnitude for positive and negative stimuli.

Relation With Mere Exposure

A large body of work (e.g., Bornstein, Leone, & Galley, 1987; Kunst-Wilson & Zajonc, 1980; Monahan, Murphy, & Zajonc, 2000; Murphy & Zajonc, 1993; Zajonc, 1968) has demonstrated that mere exposure to stimuli causes these stimuli to be perceived as more positive or more likable. At first glance, the

affective habituation hypothesis and the data we gathered seem to contradict this work. We found that repeated exposure led to decreased perceived extremity: negative stimuli were indeed perceived as more positive, but positive stimuli were seen as *less* positive.

However, our analysis pertains to extreme stimuli, whereas the work on mere exposure deals with stimuli that are novel, evaluatively neutral, or both. This difference is crucial. Monahan et al. (2000) recently argued that mere exposure to neutral stimuli leads to diffuse positive affect. This positive affect, in turn, causes such stimuli to be evaluated more favorably. More important, this diffuse positive affect is elicited by an absence of any negative consequences (i.e., negative affective reactions) while being presented with these stimuli. Conversely, in our experiments, we used extreme stimuli that do evoke immediate and strong affective reactions. In sum, both the underlying mechanisms as well as the class of stimuli involved are very different for mere exposure and for affective habituation.

A Note on Desensitization

Our results, especially the fact that they were obtained after subliminal exposure, have interesting implications for our understanding of desensitization. Systematic desensitization is often applied to help patients overcome phobias and other psychological disorders (Jones, 1924; Wolpe, 1958). It is very well possible that affective habituation is the crucial process underlying the effectiveness of desensitization. That is, repeated exposure to a feared stimulus leads to more moderate (rather than intense) reactions of the affective system, which makes the feared stimulus subjectively less fearful.

If indeed the process of affective habituation is responsible for successful application of desensitization, the notion that subliminal exposure also leads to habituation has important clinical implications. After all, the first stages of a desensitization program are often highly unpleasant for a patient. Among those who are phobic, even exposure to images of the feared object can lead to anxiety. Subliminal exposure to such images may already reduce the phobia while at the same time preventing emotional reactions that are too extreme or too unpleasant. It should be taken into account, though, that emotionally laden stimuli, even when presented very briefly, can still lead to emotional reactions of some intensity (e.g., Öhman & Soares, 1994). Future research may shed light on whether the subliminal desensitization can provide a useful tool.

Why We Deal Well With Extreme Stimuli

Obviously, all organisms need to deal effectively with extreme stimuli, otherwise they will be overwhelmed with happiness or eaten by lions. However, such an organism is not easy to design. First and foremost, it is of utmost importance that the organism quickly detects an extreme stimulus (see also Dijksterhuis & Aarts, in press) and, simultaneously, that it detects *how extreme* that stimulus is. One way to do this is to create a system that gives an immediate response that is mild when the stimulus allows it to be, but that is strong when a stimulus is extreme. However, such a strong response, necessary as it may be, comes with a cost: it interferes with the other processes the organism needs to put into motion, such as approach or avoidance behavior. Ideally, one would design a system that (a) gives an immediate and strong response to an extreme stimulus and (b) makes sure this strong response is not prolonged in order to give other psychological processes the chance to take over. Affective habituation satisfies this important second requirement.

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