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Of Snakes and Succor: Learning Secure Attachment Associations With Novel Faces via Negative Stimulus Pairings

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Abstract

Integrating ideas from Mikulincer and Shaver's (2003) process model of attachment and Nelson and Panksepp's (1998) neurobiological theory of an integrated social emotion system, we predicted novel attachment-related learning effects. In two experiments, we tested for a unique form of conditioning based on the social regulation of emotion. Consistent with this theoretical integration, the results indicated that people develop more positive and less negative associations with faces of people who display genuine smiles if those faces have been implicitly paired with a distressing stimulus (e.g., a striking snake). These findings could have broad implications and should be of interest to researchers who study attachment, social and affective neuroscience, emotion, learning and memory, attitudes, and interpersonal relationships.

Keywords

attachment, interpersonal relationships, emotion, affect regulation, learning

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During the past few decades, the study of interpersonal ties has become increasingly central in research on human social behavior. Human beings, for example, have a basic need to feel connected and to "belong" in social groups (Baumeister & Leary, 1995). But how do humans become connected to others? What mechanisms support the maintenance and development of affectional bonds? How do people learn and develop emotional ties to others? And are there specialized, evolved mechanisms for learning emotional associations with certain people? These questions lie at the heart of what it means to be a "social animal," and they are among the most fundamental questions in psychology today.

Relationships are believed to serve protective functions, particularly during difficult, stressful, or challenging times (Bowlby, 1969). Their protective value has been documented in many studies that have shown the stress-buffering effects of confiding in other people and receiving support from them (e.g., Pennebaker, 1990; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). Much less is known, however, about the mechanisms that generate feelings of support and trust in others and the processes that emotionally bind people together. The research reported here illuminates one process by which people learn, in an implicit, automatic manner, to form a sense of felt security with novel others.

Bowlby (1969, 1973, 1980) believed that humans have an innate psychobiological system, termed the attachment system, that motivates young, vulnerable children to maintain close physical proximity to their caregivers. Ainsworth, Blehar, Waters, and Wall (1978) documented individual differences in children's patterns of attachment to their parents (caregivers), distinguishing between secure and insecure attachment patterns. One cardinal difference between individuals classified as secure versus insecure is how they regulate and control negative affect. Securely attached individuals are confident that others will be available, responsive, and supportive in times of need, which allows them to use others as sources of comfort and support to assuage and control negative affect when it arises. Insecurely attached individuals, in contrast, harbor doubts about the availability and responsiveness of others, which leads them to use other coping tactics to mitigate and control negative affect.

According to Mikulincer and Shaver (2003), attachment bonds in adults develop from repeated activation of the attachment system, which is triggered by the threat of separation or impending danger. When an attachment figure is psychologically available and responsive, imminent distress is alleviated,

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and a sense of felt security ensues (Sroufe & Waters, 1977). When an attachment figure is not available or responsive, however, individuals remain distressed and typically develop insecure attachment patterns, or styles. Two primary forms of attachment insecurity exist in adults (Mikulincer & Shaver, 2003). Anxious individuals worry that their needs for security will not be sufficiently met. This motivates them to use hyperactivating strategies aimed at achieving proximity to and support from their attachment figures. This behavior is analogous to that seen in anxious-resistant children in the strange situation; they are highly distressed by the absence of their attachment figures and are difficult to console upon reunion with their attachment figures (Ainsworth et al., 1978). Avoidant individuals are instead concerned about maintaining sufficient independence and autonomy in their relationships. This motivates them to use hypoactivating strategies, such as denying the need for support and intimacy, especially in stressful situations. This behavior is analogous to the behavior seen in anxious-avoidant children in the strange situation; they appear indifferent to the absence of and reunion with their attachment figures (Ainsworth et al., 1978).

Very little is known about how new attachment relationships develop and what normative mechanisms are involved. Some of the best work to date comes from biological and animal models. Hofer's (1995, 2006) research, for example, has demonstrated that mother-infant interactions regulate affective and physiological systems, indicating that attachment bonds serve important affective-regulatory functions. Coan, Schaefer, and Davidson (2006) recently found that holding another person's hand while receiving painful shocks—especially holding the hand of a spouse with whom one is happy—reduces activity in brain regions known to regulate negative affective responses.

Panksepp and his colleagues have offered another perspective that may provide key insights into normative processes underlying attachment and bonding. Nelson and Panksepp (1998) proposed that the brain contains an integrated social emotion system that includes both a separation-distress subsystem and a social-reward/contact-comfort subsystem. The separation-distress subsystem overlaps with the physical-pain circuit (Eisenberger, Lieberman, & Williams, 2003; Nelson & Panksepp, 1998) and is down-regulated by activation of the social-reward/contact-comfort subsystem. Activation of the latter subsystem generates euphoria and the development of conditioned preferences (Carr, Fibriger, & Phillips, 1988).

By combining features of Nelson and Panksepp's (1998) model of an integrated social emotion system and Mikulincer and Shaver's (2003) model of attachment processes, one can derive predictions about how people develop emotional bonds via a conditioning process that depends on the emotional responsiveness of novel people (i.e., strangers). When an individual experiences a threat, the separation-distress subsystem should become active, motivating support seeking and pain relief. If another person is available and responsive, the social-reward/contact-comfort subsystem should be activated, exerting an inhibitory effect on the separation-distress subsystem. The down-regulation of the separation-distress subsystem and the up-regulation of the social-reward/contact-comfort subsystem should produce feelings of comfort, relief, and security, which eventually become associated with the responsive other.

The role of distress in learning secure associations with others is currently disputed (Mikulincer & Shaver, 2007). Several theorists (e.g., Baldwin, 2007; Ryan, Brown, & Cresswell, 2007; Saribay & Andersen, 2007; Schaller, 2007) have proposed mechanisms that could result in the development of secure-attachment schemata in the absence of distressing events (e.g., in situations characterized by unconditional positive regard, support for autonomy, and warm, reassuring social connections). However, according to attachment theory (Bowlby, 1969; Simpson & Rholes, 1994), vulnerability and distress should play an important, and perhaps essential, role in developing secure-attachment representations. In this view, it is not being treated warmly that leads to feeling secure with another person; it is feeling protected and calmed in aversive situations.

In this article, we report two experiments in which we sought to demonstrate a form of conditioned learning predicated on this theoretical reasoning. The methods we used are most similar to evaluative conditioning, which involves the transfer of valence from an unconditioned stimulus (US) to a neutral conditioned stimulus (CS; e.g., Olson & Fazio, 2001). For example, neutral (expressionless) faces paired with fearful objects (snakes) take on generally negative valence (Olatunji, Lohr, Sawchuck, & Westendorf, 2005). Unlike evaluative conditioning, however, our method tested whether previously unknown faces (i.e., faces of strangers) would assume properties *opposite* in valence to those of a US. Specifically, we predicted that when distressing stimuli (e.g., a picture of a striking snake) are implicitly presented right before faces with expressions meeting Mikulincer and Shaver's (2003) criterion for an available and responsive attachment figure (e.g., genuine, warm Duchenne smile), such faces take on positive interpersonal associations after several conditioning trials.

The presentation of distressing, negative stimuli immediately before the faces in our paradigm was critical. In typical attachment interactions, distressing events or stimuli are encountered first, followed by proximity seeking and efforts to obtain support and reassurance from the caregiver (Bowlby, 1969). Thus, in our conditioning paradigm, a negative stimulus was presented first, followed immediately by the stimulus for which we were attempting to produce a conditioned response (i.e., a face that had a specific expression).

We hypothesized (a) that Duchenne-smiling faces paired with a negative stimulus (a striking snake, a mutilation scene) during initial learning trials would become more strongly associated with words reflecting attachment security and more weakly associated with words reflecting attachment insecurity than would Duchenne-smiling faces paired with a neutral stimulus (a rolling pin, a basket), and (b) that these effects would not be found for positive and negative non-attachment-relevant words. Moreover, we expected to find the significant interaction between conditioning (negative vs. neutral US) and attachment-word valence (positive vs. negative) only for faces showing Duchenne smiles (i.e., not for faces with neutral expressions).

Experiment 1

Experiment 1 was designed to test for this unique conditioning effect using only Duchenne-smiling faces as the CSs. We presented the USs implicitly (too briefly for explicit recognition) during a learning phase and then used a lexical decision task during the test phase to minimize potential demand effects. In the computerized lexical decision task, the face pictures that had just been paired with either a distressing or a neutral US were used as primes before target words and letter strings. Participants were asked to report whether each target was a word or a nonword as quickly and accurately as possible. Thus, this task assessed the degree of association between the pictures and the targets. A faster correct response indicated a stronger association between the picture prime and the target.

This type of conditioning is likely to be an implicitly mediated phenomenon controlled by basic interpersonal learning mechanisms linked with the integrated social emotion system. To simulate responsive others, we used photos of strangers who displayed warm Duchenne smiles as the CSs (i.e., as stimuli that conveyed nonverbal signals of responsiveness immediately following brief implicit exposure to a picture of a feared object).

Method

Experimental design. We used a 2 (word type: attachment vs. non-attachment) × 2 (conditioning: fearful vs. neutral US) × 2 (word valence: positive vs. negative) within-subjects design. Self-reported attachment orientations (both anxiety and avoidance) were also measured and included in all models.

Participants. Forty-eight undergraduates (19 men, 29 women) participated in exchange for extra credit in a course they were taking. They ranged in age from 16 to 29 years ($M = 20.0$). The sample included 1 Black, 4 Asian, and 34 White participants, as well as 9 participants who described themselves as Hispanic or "other."

Stimulus materials. Facial photos were selected from the NIMSTIM database (Tottenham, Borscheid, Ellertsen, Marcus, & Nelson, 2002).[1] All photos were taken at close range; the eyes looked forward, and the faces displayed Duchenne smiles. Image resolution was 350 × 450 dpi, and images were presented in gray scale. Sixteen raters rated each face on attractiveness, warmth, and likeability. Two female faces and two male faces were then selected as the CSs. The selection criteria required that each picture was rated as less than 1 standard deviation from the mean for the other same-sex faces on each of the three rated dimensions.

Four categories of stimulus words were used: secure, insecure, positive non-attachment (e.g., *awesome*, *brilliant*), and negative non-attachment (e.g., *corrupt*, *weapon*). The attachment words were chosen on the basis of a review of the attachment literature (e.g., Shaver & Mikulincer, 2002). The secure attachment words were as follows: *attentive*, *calm*, *care*, *close*, *comfort*, *confide*, *kind*, *nurture*, *protect*, *responsive*, *safe*, *secure*, *sensitive*, *support*, *trust*, and *warm*. The insecure attachment words were as follows: *alone*, *anxiety*, *avoid*, *cold*, *cruel*, *despair*, *distant*, *distress*, *fear*, *mean*, *needy*, *neglect*, *rejection*, *single*, *threat*, and *vulnerable*. Each of the four word categories was divided into two lists, and the lists were counterbalanced on word length, word frequency (Kucera & Francis, 1967), and valence (e.g., the negative and insecure lists were equally negative, according to the ratings of 16 raters). Sixty-four nonwords similar in length to the real words were also used.

The pictures used as USs, a snake about to strike (the negative US) and a rolling pin (the neutral US), were selected from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2005). A scrambled scene the same size as the USs (resolution of 512 × 384 dpi) was used as a mask.

Procedure. After participants gave their informed consent, they completed a survey (privately) that included the Adult Attachment Questionnaire (Simpson, Rholes, & Phillips, 1996), which measures levels of anxiety and avoidance toward romantic partners in general. We included these measures to test whether they interacted with any of the independent variables.

Next, participants were seated at a computer, given instructions for the learning phase, and told that it was critical to keep their eyes focused on the computer-displayed images at all times. During the learning phase, one US was systematically backward-paired with one set of CSs (one male face and one female face), and the other US was paired with the other two faces. The pairings were counterbalanced across participants. The snake image was used to induce fear, given evolved mechanisms for snake detection that function implicitly and automatically (Öhman & Mineka, 2001). The rolling pin was used as a neutral (control) stimulus. Learning trials consisted of the following sequence: 2-s fixation point, 14-ms US presentation, 184-ms mask presentation, 800-ms blank screen, 3-s presentation of a face (see Fig. 1). Each face was paired with a US for 20 trials, for a total of 80 learning trials.

The test phase involved CS-primed word/nonword judgments. Specifically, participants pressed the "b" key on a computer keyboard if the target stimulus was a word, and the "n" key if it was a nonword (i.e., a random series of letters). They were asked to make each response as quickly as possible while still being accurate. Each trial began with a 500-ms fixation point, which was followed by a 500-ms presentation of the CS prime and then a letter string. The letter string remained on the screen until the response was given, so as to maximize accuracy. Pairing of word lists with face sets was counterbalanced across participants.

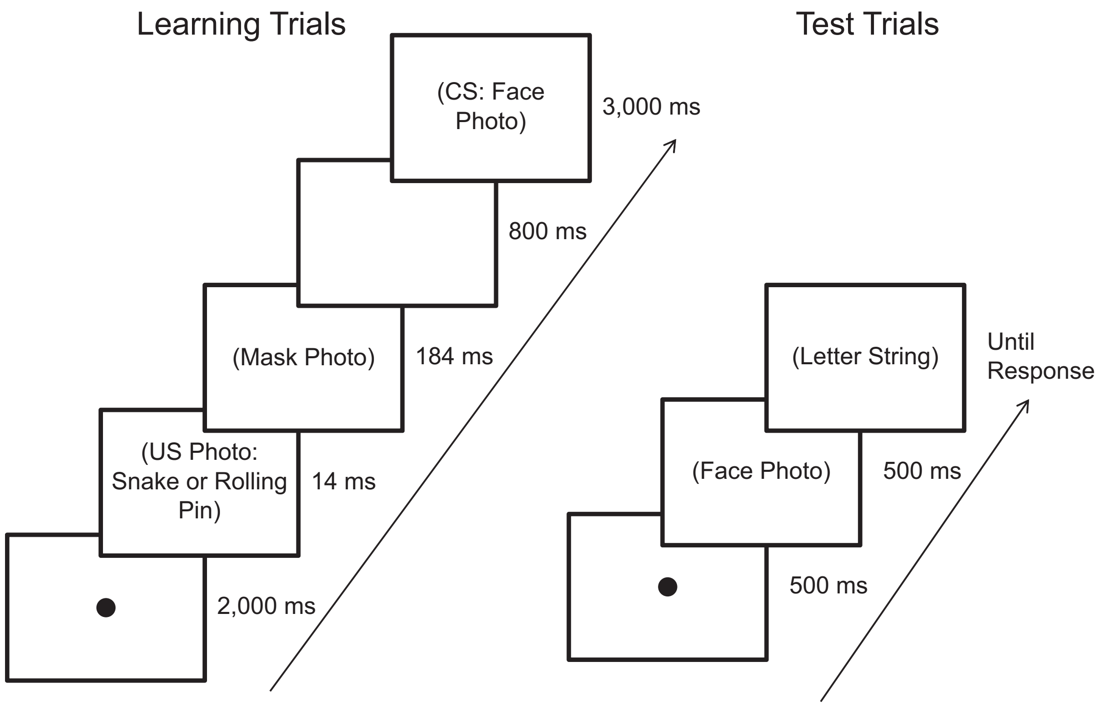

Fig. 1. Schematic outlining the general method used in both experiments. Learning trials paired unconditioned stimuli (USs) with conditioned stimuli (CSs). Associations between the CSs and word categories were then tested.

Following the test phase, participants were debriefed to probe for recall of the masked USs. No one reported explicit awareness of the striking snake, and no one suspected the hypotheses that were being tested.

Results

Average accuracy rates (i.e., percentages of correct word/nonword judgments) were above 95% and significantly above chance, $p < .001$, indicating that participants followed the instructions well. We used the Linear Mixed Models program in SPSS to analyze the data. This allowed us to test within-subjects experimental effects while keeping the self-reported attachment measures in their continuously distributed form. All reported effects were nested within significant models, and attachment-word trials were analyzed separately from non-attachment-word trials. Analyses were conducted after removing (a) response times (RTs) that were 3 or more standard deviations from the mean and (b) trials with incorrect responses.

Attachment words. The final model included the following independent variables: conditioning, attachment-word valence, gender, and attachment anxiety. (Attachment avoidance was not included because it did not yield significant effects in any of the preliminary models.) We report all significant main effects and interactions (up to three-way interactions).

As predicted, a significant interaction between conditioning (snake vs. rolling pin) and attachment-word valence (secure vs. insecure) emerged, $b = -9.79$, $t(125) = -2.14$, $p = .034$. Priming secure words with snake-paired faces resulted in faster RTs than did priming these words with rolling-pin-paired faces (see Fig. 2). A secondary analysis revealed a marginally significant main effect of conditioning on RTs for secure words, $b = -8.67$, $t(45) = -1.36$, $p = .090$.[2] Priming insecure words with snake-paired faces produced slower RTs than did priming these words with rolling-pin-paired faces, as confirmed by a secondary analysis revealing a significant main effect of conditioning on RTs for insecure words, $b = 11.78$, $t(45) = 1.93$, $p = .031$.

Non-attachment words. As predicted, the analysis conducted on the non-attachment words revealed no interaction between conditioning and word valence, $p = .829$.

Self-reported attachment. Participants' self-reported attachment styles did not moderate the interaction between conditioning and attachment-word valence. Some main effects of attachment anxiety and interactions with participant gender were found.[3]

Discussion

Experiment 1 supported the central hypothesis that pairing an implicitly presented distressing stimulus (a striking snake) with a Duchenne-smiling face conditions a positive, attachment-specific association to that face. This finding is novel and important in four respects. First, it is the first demonstration of a negative US producing an increase in positive associations to

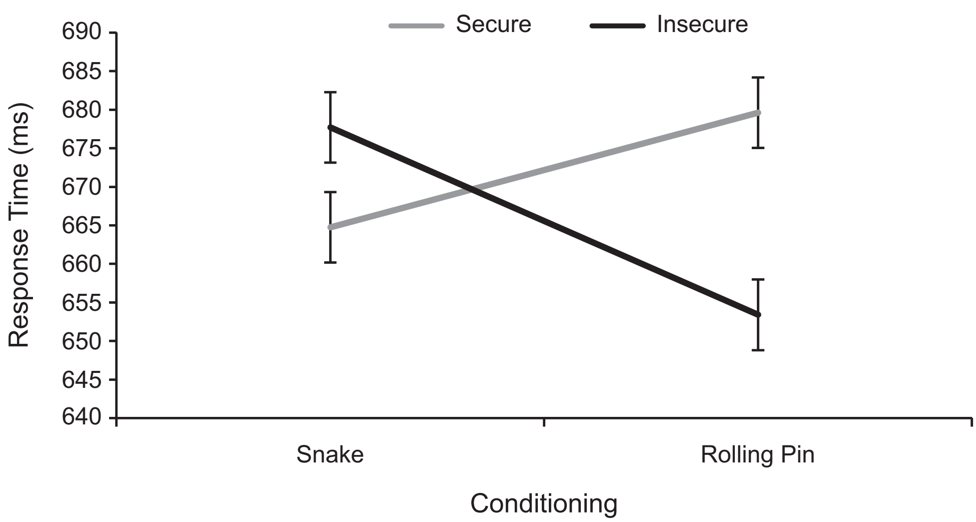

Fig. 2. Results from Experiment 1: regression plot of response time as a function of attachment-word type (insecure vs. secure) and conditioning (faces paired with a snake vs. faces paired with a rolling pin).

a CS. Second, the effect appears to be attachment-specific. Third, it occurred at an implicit level of awareness, and therefore does not appear to be attributable to demand characteristics or to be governed by explicit awareness. Fourth, the effect was not moderated by self-reported adult attachment styles, which suggests that this process may be a normative one.

Our argument rests on the premise that the smiling faces convey responsiveness. Accordingly, the interaction between conditioning and word valence should not hold for nonsmiling (i.e., nonresponsive) faces. Experiment 2 was designed to test this important qualifying condition.

Experiment 2

Experiment 2 was designed to test whether the conditioning effect documented in Experiment 1 was specific to responsive facial expressions (i.e., Duchenne smiles). Faces that do not have such expressions should generate either a generalized negative association or no changes in association with attachment words. To test this hypothesis, we used another set of Duchenne faces and neutral faces. We also used a different negative US (a medical scene showing a severely damaged human body) and a different neutral US (a picnic basket) to extend our previous findings.

Method

Experimental design. The experiment had a 2 (facial expression: smiling vs. neutral) × 2 (word type: attachment vs. nonattachment) × 2 (conditioning: fearful vs. neutral US) × 2 (word valence: positive vs. negative) design, with the first factor between subjects and the other factors within subjects. Self-reported measures of attachment anxiety and mutilation, blood, and injury phobias were included in all models. Phobias were assessed to test whether the unique conditioning effects were stronger in people who had greater mutilation, blood, and injury phobias.

Participants. Ninety undergraduate students (37 men, 53 women) participated in exchange for extra credit in a course they were taking. Participants ranged in age from 16 to 28 years (M = 19.2). The sample included 78 Whites, 8 Blacks, 3 Asians, and 1 person who indicated "other" ethnicity.

Stimulus materials and procedure. The stimulus materials and procedure were the same as in Experiment 1, with the following exceptions. We used a different set of faces and included both faces with Duchenne smiles and faces with neutral expressions. A medical photograph showing severe injury to a human body replaced the snake image as the negative US, and a picture of a picnic basket replaced the rolling pin as the neutral US. Participants also completed the Mutilation Questionnaire (Klorman, Hastings, Weerts, Melamed, & Lang, 1974), which measures phobias regarding mutilation, blood, and injury. A box or a diamond appeared immediately after each face in the learning trials, and participants were asked to report this shape. We included this task to ensure that they paid close attention during the learning trials. As in Experiment 1, during debriefing no one reported explicit awareness of the negative US or suspicion of the hypotheses.

Results

Average accuracy rates (i.e., the percentages of correct word/nonword judgments) were 95% for the entire sample, significantly above chance, $p < .001$. We used the Linear Mixed Models program in SPSS to test the hypotheses. Analyses were conducted after removing (a) RTs 3 or more standard deviations from the mean and (b) trials with incorrect word/nonword judgments.

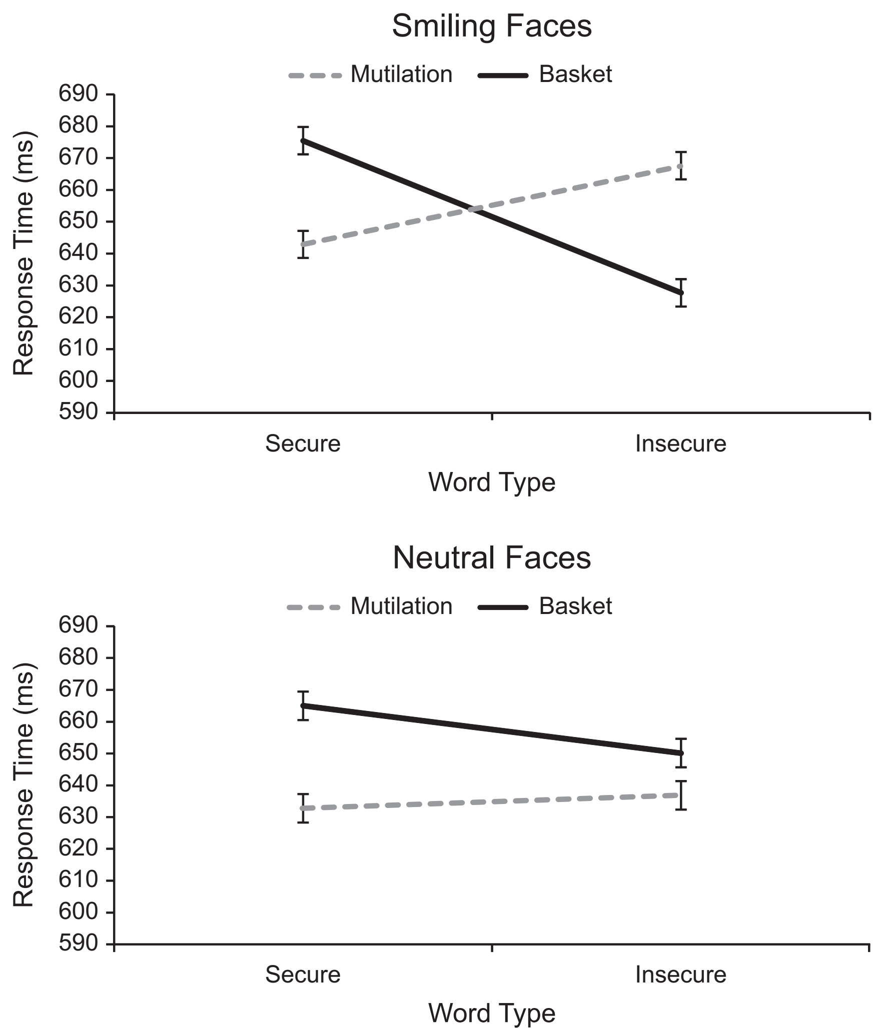

Fig. 3. Results for the smiling faces (top panel) and neutral faces (bottom panel) in Experiment 2: regression plots of response time as a function of attachment-word type (insecure vs. secure) and conditioning (faces paired with a mutilation scene vs. faces paired with a picnic basket).

Attachment words. The final model included the following independent variables: facial expression, conditioning, attachment-word valence, gender, self-reported mutilation fear, and self-reported attachment anxiety. All significant main effects and interactions (up to three-way interactions) are reported.

The analysis for attachment words revealed the predicted three-way interaction of facial expression, conditioning, and word valence, $b = -6.70$, $t(228) = -2.04$, $p = .043$. For the smiling faces, RTs to secure words were faster if the faces had been paired with the medical scene than if they had been paired with the picnic basket, whereas RTs to insecure words were slower if the faces had been paired with the medical scene than if they had been paired with the picnic basket (see Fig. 3). For the neutral faces, there was no interaction between attachment-word valence and conditioning, a finding supporting our hypotheses. A secondary analysis, in which the smiling and neutral faces were analyzed separately, confirmed that the smiling faces were mainly responsible for the interaction between conditioning and word valence, as the interaction approached significance for the smiling faces, $b = -6.71$, $t(131.48) = -1.563$, $p = .12$, and was not close to being significant for the neutral faces, $b = 3.56$, $t(94.63) = 0.793$, $p = .430$.

A third set of analyses revealed that in the case of the smiling faces, there was a marginally significant main effect of conditioning on RTs for positive attachment words, $b = -9.79$, $t(49) = 1.471$, $p = .074$. No main effect of conditioning on RTs for negative attachment words was found, $b = 3.63$, $t(49) = 0.650$, $p = .259$. In general, however, the pattern of the data was very similar to that in Experiment 1.

Non-attachment words. An analysis on the non-attachment words revealed no interaction of facial expression, conditioning, and word valence, $p = .829$.

Self-reported attachment and phobias. No significant effects of self-reported attachment style on the interactions of interest were found. An interaction between self-reported mutilation, blood, and injury phobia and facial expression indicated that greater self-reported phobia was associated with shorter RTs to smiling faces and longer RTs to neutral faces that primed non-attachment words, $b = -3.93$, $t(75) = -2.40$, $p = .019$.

Discussion

By using smiling as well as neutral facial expressions, we found that the conditioning effect is specific to smiling faces. This suggests that the responsiveness of facial expressions is a critical variable in these experiments and that the conditioning effect is not simply an artifact of the US-CS order within the pairings.

General Discussion

These experiments offer novel insights into attachment-related social emotion and learning processes by documenting a unique interpersonal conditioning phenomenon anticipated by attachment theory. The findings indicate that when a responsive other repeatedly appears following implicit exposure to a distressing or threatening stimulus (a striking snake or a threatening medical scene), implicit learning processes lead that responsive other to become associated with secure representations. This implicit conditioning process may also play an important role in forging trust between new partners in certain situations (Simpson, 2007), launching emotional bonds.

The current research also suggests new ways in which neurobiological models and attachment findings might be integrated with other social and developmental perspectives (e.g., Simpson, Beckes, & Weisberg, 2008). It has particular importance for advancing researchers' understanding of how normative attachment and bonding processes transpire in humans. This research also provides support for Mikulincer and Shaver's (2003) process model of attachment by placing components of their model in the context of Nelson and Panksepp's (1998) integrated social emotion system. Secure attachment should develop when another person is consistently available and responsive to a distressed individual. Our experiments confirm that when faces that contain responsive expressions are presented immediately following a distressing stimulus, they become associated with secure attachment concepts. This finding indicates that distress is a critical element in developing secure ties with others, and it shines new light on important questions and controversies about how psychological security is achieved.

These results also support interpersonal theories suggesting that therapeutic relationships are the foundation for therapeutic change. According to Strupp (1980), clients change when emotionally painful relational scenarios are reexperienced with a therapist. If therapists are emotionally available, supportive therapeutic relationships can give rise to new outcomes. Understanding how distress relates to security could aid in refining such therapeutic techniques.

Future research should replicate and test the boundary conditions of this conditioning effect. For example, studies should examine alternative distressing stimuli, facial expressions, and dependent measures and should investigate the neurobiological substrates that underlie this phenomenon.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Notes

1. For more information, contact Nim Tottenham at tott0006@tc.umn.edu.
2. Because we had a priori directional hypotheses, a one-tailed test was used to test all simple main effects.
3. There was an interaction between gender and attachment anxiety. Anxious men were faster at responding to attachment words than were less anxious men, $b = -7.04$, $t(42) = -2.59$, $p = .013$; however, anxious men were not faster than anxious women at responding to attachment words. A similar anxiety effect for men emerged for non-attachment words, $b = -6.51$, $t(42) = -2.18$, $p = .035$. More anxious individuals made faster word/nonword judgments in the case of non-attachment words, $b = -6.79$, $t(42) = -2.26$, $p = .029$.

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