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A Safe Haven: Investigating Social-Support Figures as Prepared Safety Stimuli

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Abstract

Although fear-conditioning research has demonstrated that certain survival-threatening stimuli, namely *prepared fear stimuli*, are readily associated with fearful events, little research has explored whether a parallel category exists for safety stimuli. We examined whether social-support figures, who have typically benefited survival, can serve as *prepared safety stimuli*, a category that has not been explored previously. Across three experiments, we uncovered three key findings. First, social-support figures were less readily associated with fear than were strangers or neutral stimuli (in a retardation-of-acquisition test). Second, social-support stimuli inhibited conditional fear responses to other cues (in a summation test), and this inhibition continued even after the support stimulus was removed. Finally, these effects were not simply due to familiarity or reward because both familiar and rewarding stimuli were readily associated with fear, whereas social-support stimuli were not. These findings suggest that social-support figures are one category of prepared safety stimuli that may have long-lasting effects on fear-learning processes.

Keywords

prepared safety stimuli, social support, fear conditioning, social buffering

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Being able to learn cues that predict threat or danger, a process called *fear learning*, is critical for survival. Indeed, studies of Pavlovian fear conditioning have shown that fear responses are rapidly acquired to neutral cues associated with aversive events (e.g., shocks; Davey, 1992; Delgado, Olsson, & Phelps, 2006; Pavlov, 1927). Moreover, in both humans and nonhuman animals, fear learning occurs more effectively with certain stimuli (M. Cook & Mineka, 1990; Newton, Ellsworth, Miyakawa, Tonegawa, & Sur, 2004; Sigmundi, Bouton, & Bolles, 1980). Thus, *prepared fear stimuli*—stimuli that have historically threatened survival (e.g., snakes, spiders)—are readily associated with aversive events, which leads to exaggerated conditional fear responses that are then harder to extinguish (E. W. Cook, Hodes, & Lang, 1986; Ohman, Fredrikson, & Hugdahl, 1978; Ohman & Mineka, 2001; Seligman, 1971).

However, little research has examined the parallel notion of *prepared safety stimuli*—stimuli that may have historically benefited survival and thus may be more readily associated with safety and therefore inhibit fear responding (Jacobs & LoLardo, 1977). One category of stimuli that seems a likely candidate is social-support figures, who, over the course of evolutionary history, have provided individuals with protection, care, and resources, which has ultimately promoted survival. Indeed, research has shown that pictures of social-support figures activate neural regions implicated in detecting safety and lead to reductions in distress in response to negative events (Eisenberger et al., 2011). However, no work has examined whether social-support figures act as prepared safety stimuli.

To examine this possibility, we borrowed from work on one kind of learned safety signal, a conditioned inhibitor. Specifically, in the context of fear conditioning, conditioned inhibitors are stimuli that not only signal

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that one is safe from experiencing an aversive event, but they also inhibit the fear response for that event (Rescorla, 1969). Prepared safety stimuli should thus perform the same functions as conditioned inhibitors, but unlike conditioned inhibitors, should not require that participants receive specific training in the lab to acquire this safety value. It is also possible that they may hold other properties that lead to a more powerful inhibition of the fear response beyond that provided by conditioned inhibitors. Therefore, we conducted two tests of conditioned inhibitors for the fear response (Rescorla, 1969) to determine whether social-support figures belong in the prepared safety category, as indicated by their passing these tests without participants needing any lab-based training.

In Experiment 1, we conducted a retardation-of-acquisition test to assess whether the acquisition of a fear response to a conditional stimulus (CS) is retarded or inhibited when the CS is a social-support figure, defined here as the people from whom an individual perceives receiving the most social support (care, resources) on a daily basis. Specifically, we examined conditional fear responses in response to pairing a social-support-figure stimulus with an electric shock as well as in response to pairing stranger and neutral stimuli with an electric shock. We hypothesized that, although conditional fear responses would be acquired to the stranger and neutral stimuli, no conditional fear response would be acquired to the social-support stimuli.

In Experiment 2, we conducted a summation test to assess whether social-support-figure stimuli inhibit other conditional fear responses. For this test, after training participants to acquire conditional fear responses to neutral stimuli, we paired these now fearful neutral stimuli with social-support stimuli (as well as stranger and neutral stimuli) and examined whether the conditional fear response was inhibited. We hypothesized that, although stranger and neutral stimuli would not inhibit the fear response, social-support stimuli would weaken the fear response elicited by other learned threats when they were present, and possibly even after they were removed. Together, these tests allowed us to evaluate whether social-support stimuli are prepared safety stimuli.

Finally, to isolate the aspects of social-support stimuli that might be driving these effects, we tested, in Experiment 3, whether conditional fear responses could be acquired to familiar or rewarding stimuli. This allowed us to determine whether other confounding features of social-support stimuli, such as their familiarity or reward value, might be driving the effects observed here. We hypothesized that, although conditional fear responses would be acquired to familiar (images of current professors) and rewarding (images of favorite foods) stimuli, no conditional fear response would be acquired to the social-support stimuli.

General Method

Participants

Data were analyzed from a final sample of 20 participants (mean age = 21.05 years; 8 women, 12 men) for Experiment 1, 20 participants (mean age = 19.65 years; 14 women, 6 men) for Experiment 2, and 20 participants (mean age = 20.10 years; 14 women, 6 men) for Experiment 3 (see the Supplemental Material available online). Sample sizes were based on those used in previous research (see Olsson, Ebert, Banaji, & Phelps, 2005; Schiller et al., 2010). Participants were recruited from the University of California, Los Angeles (UCLA) community. Experimental procedures were approved by the UCLA Institutional Review Board.

Procedure

The overall procedure for all three experiments was similar. Participants first completed a telephone screening and a prescreening session to determine whether they were eligible to participate in the study (see the Supplemental Material). During the prescreening session, they were asked to fill out a questionnaire regarding social-support figures that required them to select "the two individuals who give you the most social support on a daily basis" (Experiments 1 and 3) or "the individual who gives you the most social support on a daily basis" (Experiment 2) and then to rate how much social support these individuals give them every day on a scale from 1 to 10. They were then instructed to send digital photographs of these individuals to the experimenter before the experimental session.

Participants then returned to the lab for the experimental session, during which they first underwent a shock-calibration procedure to determine the appropriate level of shock to be applied during the experiment (see the Supplemental Material). The shock was calibrated individually for each participant such that it was extremely uncomfortable but not painful. After this, the unique fear-conditioning procedures for each experiment were employed (see Method for each experiment). During the experiment, skin conductance response (SCR), an index of physiological arousal, was collected as a measure of learned fear (see the Supplemental Material). Data were preprocessed following guidelines suggested by Figner and Murphy (2011) and then scored using separate scoring strategies to find the means that represented responses during the different stages of the experiments (see the Supplemental Material).

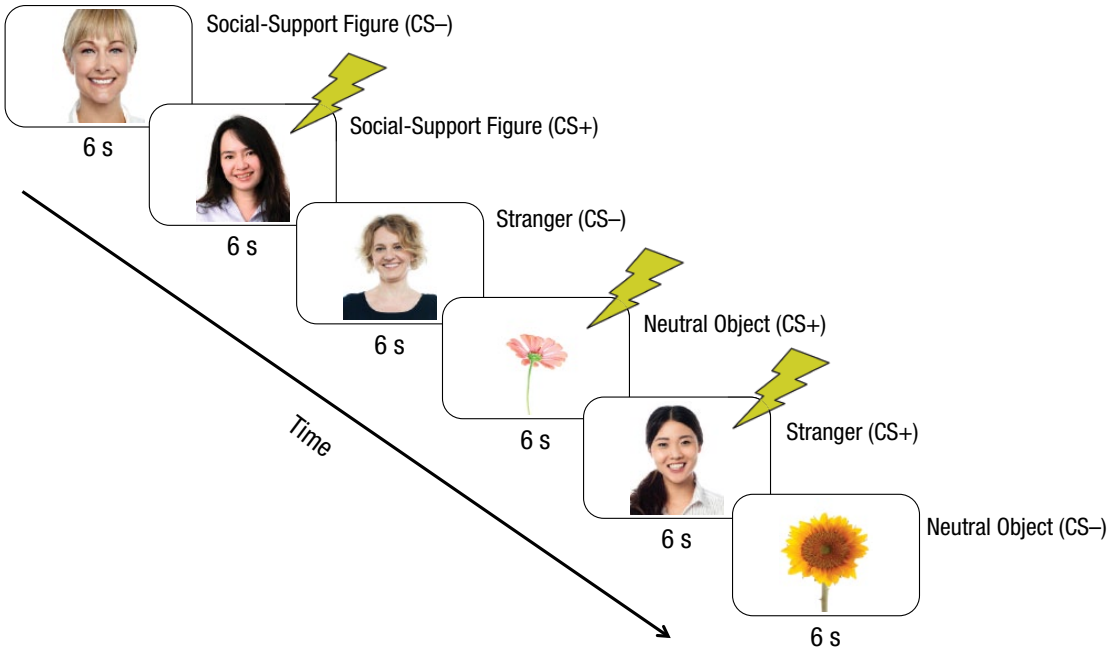

Fig. 1. Example trial sequence from the acquisition stage of Experiment 1. Participants were shown a series of images from three sets of conditional stimuli (CSs): (a) two images of social-support figures, (b) two images of strangers, and (c) two images of neutral objects. One image from each set was consistently paired with an electric shock (CS+), and the other image was never paired with a shock (CS–). Conditional fear responses were measured by calculating the difference between mean skin conductance responses (SCRs) to the CS+ and the CS– from each set. From upper left to lower right, the images are courtesy of stockimages (first, third, and fifth), posterize (second and sixth), and mapichai (fourth) at FreeDigitalPhotos.net.

Experiment 1

Method

In Experiment 1, we used a retardation-of-acquisition procedure to examine whether it was difficult to acquire a conditional fear response to an image of a social-support figure but not to an image of a stranger or neutral object.

Retardation-of-acquisition procedure. For the retardation-of-acquisition procedure, participants underwent a session of fear conditioning with three sets of stimuli: (a) two images of social-support figures, (b) two images of strangers (age-, gender-, and ethnicity-matched to the social-support figures), and (c) two images of neutral objects (flowers, mushrooms). For each stage of the experiment (habituation, acquisition, extinction), images were presented in a pseudorandom order for 6 s each, with a 1.5-s interstimulus interval (ISI) between each image presentation.

In the habituation stage, participants saw four nonreinforced (without shock) presentations of each image. There were no differences in mean SCRs to the six images (*p*s > .250), which eliminated the possibility that preexisting characteristics of the stimuli created later differences in SCRs.

Next, during the acquisition stage (see Fig. 1), participants saw six presentations of each image. One image from each stimulus set was consistently accompanied by a coterminating 200-ms shock (CS+; 100% reinforcement schedule), while the other image was never accompanied by a shock (CS–). SCRs to each of the two images within a set would later be compared (e.g., social-support CS+ vs. social-support CS–), with the CS– serving as a baseline by which we assessed fear arousal for the CS+. Importantly, there were no differences in social-support ratings for the social-support figures whose images were paired with shocks (M = 8.80) and for those whose images were never paired with shocks (M = 8.55), $t(19)$ = 0.893, $p > .250$, 95% confidence interval (CI) for the difference between means = [–0.34, 0.84].[1]

After the acquisition stage, participants had a break during which they viewed a short movie about airplanes. Finally, during the extinction stage, participants were shown six nonreinforced presentations of each image in order to extinguish any conditional fear responses. Images in all stages of the experiment were presented in a pseudorandom order counterbalanced across participants, and SCRs were collected during all stages.

Data-analysis strategy. Before the data were analyzed, we determined whether each participant acquired conditional fear to the CS+ in each of the three stimulus

conditions (social support, stranger, neutral) by examining whether the mean for the CS+ was greater than the mean for the CS– (by any amount of SCR; CS+ minus CS– > 0). If a participant acquired conditional fear to at least one of the stimuli, the data were included; otherwise, the participant's data were excluded (because of a high likelihood of a lack of attention or unawareness of contingencies between the conditional and unconditional stimuli; see Dawson & Schell, 1985).

To assess fear acquisition, we conducted paired-samples *t* tests to determine whether the SCR aroused by the CS+ image was significantly higher than that aroused by the CS– image in each condition, which would indicate that a fear response was acquired to that condition (see the Supplemental Material for details). In addition, we ran a repeated measures analysis of variance (ANOVA) to evaluate the effect of condition on fear acquisition, using mean SCR difference scores (CS+ minus CS– for each condition). We followed this ANOVA with post hoc paired-samples *t* tests comparing the mean difference in SCR for social-support stimuli versus stranger and neutral stimuli.

Results

As expected, participants acquired conditional fear responses to both the stranger and neutral stimuli. Specifically, SCRs were significantly greater to the CS+ than to the CS– for both the neutral stimuli, $t(19) = 2.76$, $p = .012$, 95% CI = [0.02, 0.17], and the stranger stimuli, $t(19) = 2.98$, $p = .008$, 95% CI = [0.03, 0.22] (Fig. 2). However, no conditional fear response was acquired to the social-support figures, $t(19) = -0.170$, $p > .250$, 95% CI = [–0.08, 0.06] (Fig. 2). Additionally, there was a significant effect of condition (social support, stranger, neutral) on fear learning, $F(2, 38) = 4.00$, $p = .027$, $\eta_p^2 = .174$, such that fear acquisition to the social-support stimuli was significantly reduced relative to fear acquisition to the stranger stimuli, $t(19) = -2.51$, $p = .021$, 95% CI = [–0.23, –0.02], or neutral stimuli, $t(19) = -2.45$, $p = .024$, 95% CI = [–0.17, –0.01]. These results demonstrate that fear is not readily associated with social-support stimuli, which indicates that social-support stimuli pass the retardation-of-acquisition test without participants needing any lab-based training—one of the tests necessary for identifying a prepared safety stimulus.

Experiment 2

Method

In Experiment 2, we used a summation procedure to examine whether social-support-figure stimuli, but not stranger or neutral stimuli, could reduce conditional fear responses to other learned-fear stimuli.

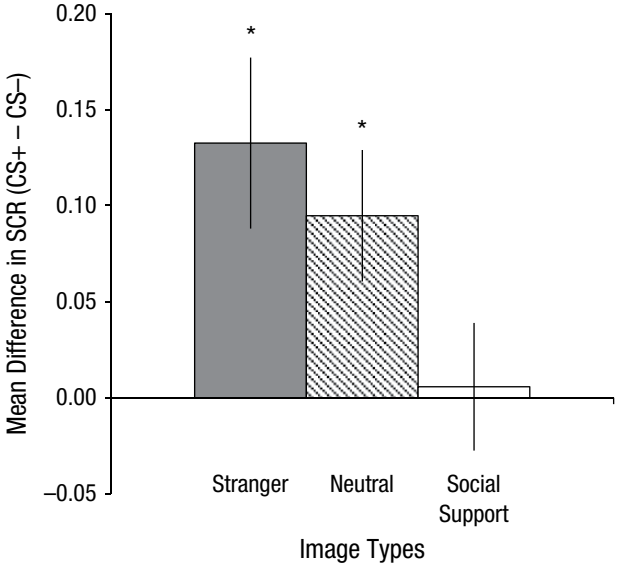

Fig. 2. Mean difference in skin conductance responses (SCRs) from the retardation-of-acquisition test in Experiment 1, separately for the three image type (stranger, neutral, social support). In each condition, participants saw two conditional stimuli (CSs), one of which was paired with shock (CS+) and one of which was not paired with shock (CS–). SCR difference scores were calculated by subtracting the mean SCR to the CS– from the mean SCR to the CS+. Error bars indicate ±1 *SE*. Asterisks indicate conditions in which the SCRs to the CS+ and to the CS– were significantly different ($p < .05$).

Summation procedure. Participants underwent a session of fear conditioning with images of four neutral stimuli (basket, stool, cup, clock), three of which would later be paired with secondary images from one of three conditions: One would be paired with an image of a social-support figure, one with an image of a stranger (age-, ethnicity-, and gender-matched to the social-support figure), and one with an image of a neutral object (flowers, mushrooms). For each stage of the experiment (habituation, acquisition, summation, test), images were presented in a pseudorandom order for 6 s each, and there was a 6-s ISI between each image presentation.

In the habituation stage, participants saw three nonreinforced (without shock) presentations of each of the neutral images. There were no differences in the mean SCRs to the four images, which verified that there were no preexisting characteristics of any of the stimuli that led to increased arousal (ps > .250).

Next, in the acquisition stage, participants saw 4 presentations each of three of the neutral images consistently accompanied by a coterminating 200-ms shock (CS+; 100% reinforcement schedule), and 10 presentations of the remaining neutral image, which was never paired with shock (CS–). After the acquisition stage, participants had a break, during which they viewed the first 3 min of a short movie about airplanes.

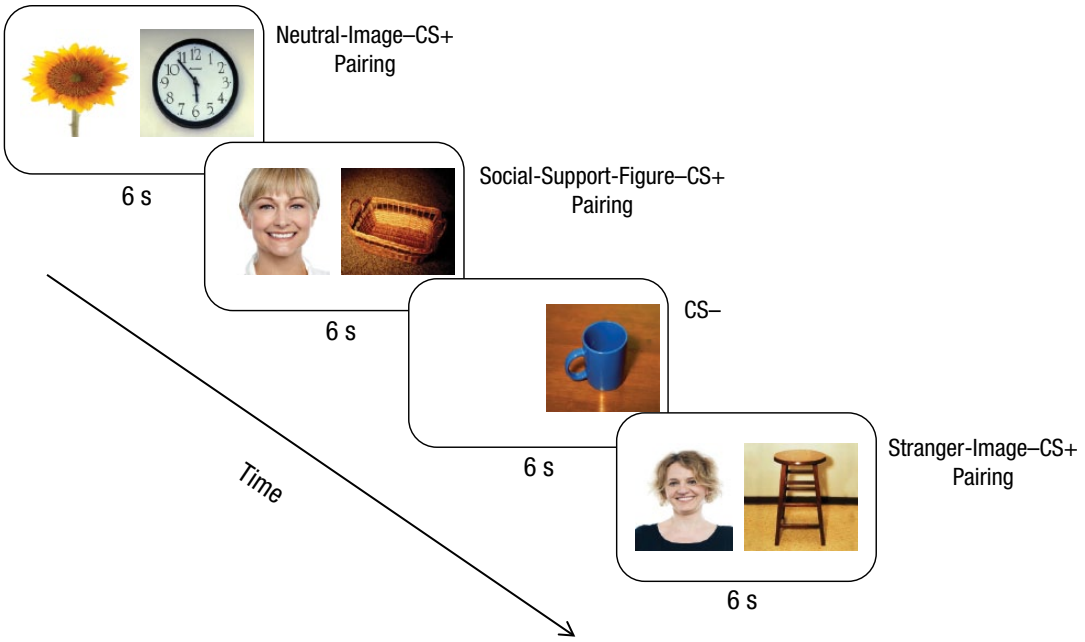

Fig. 3. Example trial sequence from the summation stage of Experiment 2. Participants were shown four conditional stimuli (CSs), three of which were paired with secondary images, and one of which was presented alone. In a previous stage (acquisition), all CSs had been presented without secondary images, but three of the CSs had been paired with shock (CS+s), and one had not been paired with shock (CS–). During the summation stage, no shocks were given. Secondary images were (a) a social-support figure, (b) a stranger, or (c) a neutral object. From upper left to lower right, the images on the left side of the secondary-image–CS+ pairings are courtesy of posterize (first) and stockimages (second and third) at FreeDigitalPhotos.net.

In the summation stage (see Fig. 3), participants saw four nonreinforced presentations of each CS+ paired with a secondary image (social support, stranger, or neutral) and four nonreinforced presentations of the CS– (not paired with any other image); all 16 presentations were in a pseudorandom order. The secondary-image–CS+ compound pairings were counterbalanced across participants so that each CS+ was paired with a different category of secondary image equally across participants. After the summation stage, participants had a second break, during which they viewed the last 3 min of the short movie.

In the final test stage, participants saw four nonreinforced presentations of each of the CS+s (without accompanying secondary image) and of the CS–. The images were presented in a pseudorandom order that was counterbalanced across participants. SCR data were collected during all stages of the experiment.

Data-analysis strategy. Before the data were analyzed, we determined whether each participant acquired conditional fear to each CS+ by examining whether the mean SCR for the CS+ was greater (by any amount) than the mean SCR for the CS– in the acquisition stage. If a participant did not acquire conditional fear to all three CS+s, the participant's data were excluded from the experiment. This was done to ensure that a conditional fear response was acquired to each CS+ before we examined whether each secondary image could inhibit the conditional fear response during the summation stage.

For the acquisition stage, paired-samples *t* tests were run to compare the mean SCR to each of the CS+s with the mean SCR to the CS– in order to determine whether the SCR aroused by the CS+ was significantly higher than that aroused by the CS–, which would indicate that participants indeed acquired a fear response to the image (see the Supplemental Material for details).

For the summation stage, paired-samples *t* tests were run to compare the mean SCR to each secondary-image–CS+ compound pairing with the mean SCR to the CS–. If these comparisons were significant, it was inferred that a fear response was exhibited and that no inhibition occurred. However, if no fear response was exhibited, it was considered that inhibition had occurred. For the test stage, paired-samples *t* tests were run to compare the mean SCR to each of the CS+s alone (after the secondary image was removed) with that of the CS–. If these comparisons were significant, it was inferred that a fear response was exhibited.

In addition, we ran repeated measures ANOVAs to evaluate the effect of stimulus type on (a) fear inhibition,

using mean SCR difference scores between each compound stimulus from the summation stage and the CS–, and (b) return of fear, using mean SCR difference scores between each CS+ and the CS– from the test stage. We followed these ANOVAs with post hoc paired-samples *t* tests examining the mean difference in SCR between the CS+s paired with social-support stimuli and the CS+s paired with stranger or neutral stimuli.

Results

Because testing summation requires examining whether conditional fear responses are reduced in the presence of an additional stimulus, we first needed to ensure that participants exhibited conditional fear responses to the different CS+s in the acquisition stage. Indeed, for the final sample, there was a significant conditional fear response to the CS+s that would later be presented with the neutral secondary image, $t(19) = 6.64$, $p < .001$, 95% CI = [0.09, 0.16], the stranger secondary image, $t(19) = 5.65$, $p < .001$, 95% CI = [0.09, 0.19], and the social-support secondary image, $t(19) = 5.21$, $p < .001$, 95% CI = [0.08, 0.18], which indicates that fear was acquired to each of these CS+s. Additionally, there were no significant differences in SCRs across the CS+s, $F(2, 38) = 0.228$, $p > .250$, $\eta_p^2 = .012$, which indicates that equivalent levels of acquisition occurred.

Once conditional fear responses were established for each of the three CS+s, we examined participants' responses to the combination of the CS+ and the secondary image in the summation stage. As expected, when the CS+ was accompanied by the stranger image, the conditional fear response was not inhibited, as evidenced by a significantly greater SCR to the stranger-image–CS+ pairing than to the CS–, $t(19) = 3.08$, $p = .006$, 95% CI = [0.02, 0.12] (Fig. 4). Similarly, when the CS+ was accompanied by the neutral image, the conditional fear response was also not inhibited, $t(19) = 2.05$, $p = .055$, 95% CI = [0.002, 0.17] (Fig. 4). However, when the CS+ was accompanied by the social-support-figure image, the conditional fear response was inhibited, as evidenced by the fact that there was no difference in SCRs to the social-support-figure–CS+ pairing than to the CS–, $t(19) = 1.04$, $p > .250$, 95% CI = [–0.04, 0.11] (Fig. 4). The effect of secondary-image type (social support, stranger, neutral) on inhibition, however, was not significant, possibly because of the smaller range of SCRs seen during the summation stage than in the acquisition and test stages, $F(2, 38) = 1.35$, $p > .250$, $\eta_p^2 = .046$. Still, these results demonstrate that social-support-figure stimuli inhibit conditional fear responding and pass the summation test without participants needing any lab-based training, which satisfies the second test of a prepared safety stimulus as defined here.

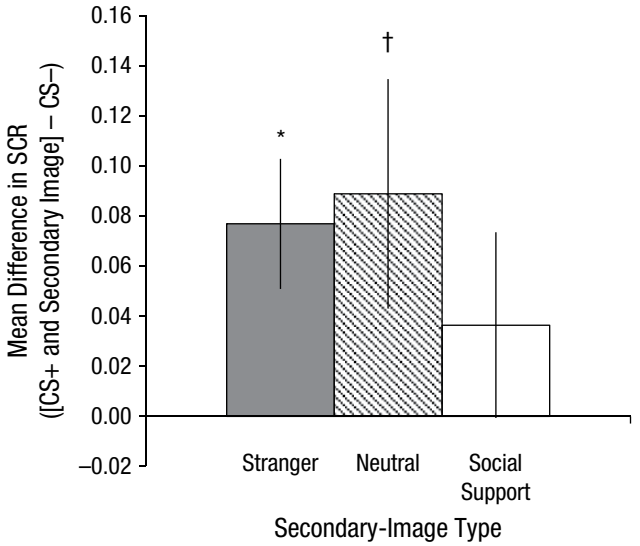

Fig. 4. Mean difference in skin conductance responses (SCRs) in the summation stage of Experiment 2, separately for the three pairings of conditional stimuli (CSs) with secondary images (stranger, neutral, social support). In the previous stage (acquisition), three of the CSs had been paired with shock (CS+), and one had not (CS–). To calculate SCR difference scores in the summation stage, we subtracted the mean SCR to the CS– from the mean SCR to the secondary-image–CS+ pairing. Error bars indicate ±1 *SE*. The asterisk and dagger indicate conditions in which the SCR to the secondary-image–CS+ pairing and the SCR to the CS– were significantly different ($p < .05$) and marginally different ($p = .055$), respectively.

We also examined responses from the test stage of the experiment, in which the secondary image was removed. Specifically, there was still a significant conditional fear response (greater SCR to the CS+ than to the CS–) after taking away the neutral secondary image, $t(19) = 4.31$, $p = .000$, 95% CI = [0.05, 0.15], and the stranger secondary image, $t(19) = 3.19$, $p = .005$, 95% CI = [0.02, 0.12] (Fig. 5). However, when the social-support-figure secondary image was removed, the conditional fear response did not return, $t(19) = –1.08$, $p = .292$, 95% CI = [–0.08, 0.03] (Fig. 5). Further examination of the effect of condition on the return of fear demonstrated a significant effect, $F(2, 38) = 9.48$, $p = .000$, $\eta_p^2 = .333$, such that there was significantly less return of fear after the social-support stimulus was removed than after the stranger stimulus, $t(19) = –2.55$, $p = .019$, 95% CI = [–0.18, –0.02], or neutral stimulus, $t(19) = –5.28$, $p = .000$, 95% CI = [–0.19, –0.08], was removed.

Together with the results from Experiment 1, these findings support the hypothesis that social-support figures act as prepared safety stimuli by showing that they pass both the retardation-of-acquisition test (Experiment 1) and the summation test (Experiment 2) without participants needing any prior lab-based training. Moreover, unlike stranger and neutral stimuli, social-support-figure stimuli appear to have somewhat lasting inhibitory effects on fear responses, even after they are removed.

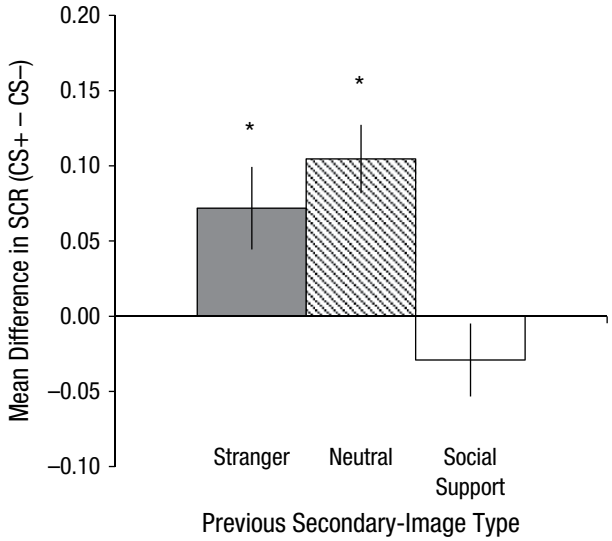

Fig. 5. Mean difference in skin conductance responses (SCRs) from the test stage of Experiment 2, separately for the three conditional stimuli (CSs) that had been paired in the previous stage (summation) with secondary images. In the initial stage (acquisition), three of the CSs had been paired with shock (CS+), and one had not (CS–). In the following summation stage, the CS+s were each paired with a unique secondary image: social-support figure, stranger, or neutral object. For the final test stage (results shown here), the secondary images were removed, and we calculated SCR difference scores by subtracting the mean SCR to the CS– from the mean SCR to each of the CS+s. Error bars indicate ±1 *SE*. Asterisks indicate conditions in which there were significant differences between the SCR to the CS+ and the SCR to the CS– ($p < .05$).

Experiment 3

To ensure that the safety effects of social-support figures were due to their value as social-support figures and not other confounding factors, such as their familiarity or reward value, we used a retardation-of-acquisition procedure in Experiment 3 to examine whether it was also difficult to acquire a conditional fear response to familiar and rewarding stimuli.

Method

For Experiment 3, in addition to asking participants to select two social-support figures, we also asked them to identify (a) stimuli that were high in familiarity but low in social support, namely two professors from courses in which they were currently enrolled (and whom they saw at least twice a week), and (b) stimuli that were high in reward value and positivity but low in social support, namely two of their favorite foods. For each selection, participants rated on a scale from 1 to 10 (a) how much social support this stimulus gave them every day, (b) how familiar this stimulus was (would they recognize the stimulus if they encountered him, her, or it by chance?), and (c) how positively they felt about the stimulus. As expected, social-support stimuli were rated highly on all three dimensions: received social support ($M = 9.20$), familiarity ($M = 9.95$), and positivity ($M = 9.63$). Familiar stimuli were rated highly in familiarity ($M = 8.50$) and positivity ($M = 7.35$) but lower in social support ($M = 4.33$). Rewarding stimuli were rated highly in positivity ($M = 9.35$) and familiarity ($M = 9.85$) but low in social support ($M = 2.37$; see the Supplemental Material for further details).

In this experiment, each participant underwent a fear-conditioning session with the three sets of stimuli that he or she provided: (a) two images of social-support figures, (b) two images of professors, and (c) two images of favorite foods. The procedures were the same as those in Experiment 1, except that for each stage of this experiment, there was a 10-s ISI instead of a 1.5-s ISI between presentations. Examination of data from the habituation stage revealed that no preexisting characteristics of any stimuli led to heightened SCRs (ps > .213); this indicates that there were no preexisting differences in the stimuli that created later differences in SCRs. The same data-analysis strategy as outlined for Experiment 1 was used to compare learned fear patterns across the three conditions in Experiment 3.

Results

We found that conditional fear responses were acquired to both the familiar and rewarding stimuli. Specifically, there were significantly greater SCRs to the CS+ than to the CS– for both the familiar stimuli, $t(19) = 6.16$, $p = .000$, 95% CI = [0.07, 0.16], and rewarding stimuli, $t(19) = 2.91$, $p = .011$, 95% CI = [0.03, 0.17] (Fig. 6). However, replicating the pattern of effects found in Experiment 1, results here showed that no conditional fear response was acquired to the social-support-figure stimuli, $t(19) = 1.56$, $p = .141$, 95% CI = [–0.01, 0.09] (Fig. 6).

Examination of the effect of condition (familiar, rewarding, social support) on fear learning revealed a significant effect, $F(2, 38) = 4.65$, $p = .016$, $\eta_p^2 = .197$; fear acquisition for the social-support stimuli was significantly reduced relative to fear acquisition for the familiar stimuli, $t(19) = -3.49$, $p = .002$, 95% CI = [–0.16, –0.04], and marginally reduced relative to fear acquisition for the rewarding stimuli, $t(19) = -1.92$, $p = .070$, 95% CI = [–0.15, 0.01].

General Discussion

Social bonds are crucial for survival, and therefore social-support figures may be one category of prepared safety stimuli—signaling protection from danger, reducing fear responding, and attenuating fear learning. However, little prior work has examined this possibility. In the present

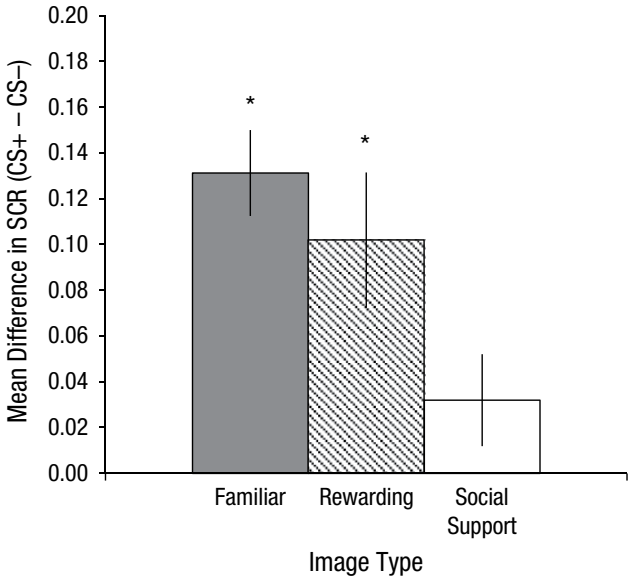

Fig. 6. Mean difference in skin conductance responses (SCRs) from the retardation-of-acquisition test in Experiment 3, separately for the three image types (familiar, rewarding, social support). In each condition, participants saw two conditional stimuli (CSs), one of which was paired with shock (CS+), and one of which was never paired with shock (CS–). SCR difference scores were calculated by subtracting the mean SCR to the CS– from the mean SCR to each of the CS+s. Error bars indicate ±1 *SE*. Asterisks indicate conditions in which the SCRs to the CS+ and to the CS– were significantly different ($p < .05$).

research, we explored whether social-support figures can serve as prepared safety stimuli by developing a definition of prepared safety stimuli based on Pavlovian-conditioning theory and testing whether social-support figures fit the parameters of that definition. Results showed that social-support figures passed both the retardation-of-acquisition and summation tests, which fulfills the requirements of a conditioned inhibitor of the fear response without participants needing training in the lab.

Specifically, in Experiment 1, participants did not learn to associate the threat of shock with an image of their social-support figure, although they did learn this association for images of strangers and neutral objects. In Experiment 2, we found that when a conditional fear stimulus was paired with an image of a social-support figure, the fear response was inhibited, whereas the fear response was not inhibited when the conditional fear stimulus was paired with images of strangers or neutral objects.

In addition, results from Experiment 2 showed that pairing social-support-figure images with a fearful cue during extinction led to a lasting inhibitory effect on the fear response. Interestingly, these results are at odds with the literature examining protection from extinction (Lovibond, Davis, & O'Flaherty, 2000; Lovibond, Mitchell, Minard, Brady, & Menzies, 2009; Rescorla, 2003), which shows that pairing a learned safety signal with a fearful cue during extinction leads to a return of fear responding when the safety signal is removed, rather than reduced fear responding, as observed here. This discrepancy in findings may be due to the fact that prior studies have not examined prepared safety stimuli (or social-support figures specifically). Thus, it is possible that prepared safety stimuli may have different effects on the return of conditional fear responses than learned safety stimuli, which makes this an important area of investigation.

Finally, in Experiment 3, we examined the possibility that the observed safety effects of social-support stimuli were due to familiarity or reward. The results of this experiment demonstrated that neither familiar individuals (current professors with whom students had frequent exposure) nor rewarding stimuli (favorite foods) passed the retardation-of-acquisition test. Therefore, these categories of stimuli, although familiar or rewarding, do not naturally signal safety and would not fulfill the requirements of prepared safety stimuli.

Although it is possible that social-support figures could simply be very well-learned conditioned inhibitors, as opposed to "prepared" safety stimuli, there are two findings that suggest that social-support figures may operate differently from other learned safety signals and thus may be "prepared" to act as safety signals. First, the present data show that unlike conditioned inhibitors or well-learned safety signals, which reduce fear in their presence but lead to a return of fear once they are removed, social-support figures continue to inhibit the fear response even after they are removed. Second, animal research has demonstrated that even animals raised by abusive caregivers show reduced threat responses when exposed to cues associated with those caregivers (Raineki et al., 2015), which indicates that even in cases where safety is not learned (such as with abusive caregivers), social-support figures can reduce threat responding.

Together, these results suggest that social-support figures may indeed be one category of prepared safety stimuli. However, unlike prepared fear stimuli, for which the specific feared stimuli are thought to require no learning and to be universal (e.g., snakes, spiders), for social-support figures as prepared safety stimuli, the *specific* support figures are learned and not universal (e.g., one social-support figure will not have a safety association for all individuals). Hence, when positing that social-support figures can function as prepared safety stimuli, the meaning is not that a specific person is a prepared stimulus for everyone, but rather that the prepared stimulus is instead a placeholder, or "slot," in the attachment behavioral system, which may be occupied by certain close individuals who serve as sources of social support. How a certain individual comes to occupy the prepared slot is unclear; however, recent work has suggested that feeling comforted by another following a period of distress might

increase feelings of attachment and security (Beckes, Simpson, & Erickson, 2010). Additional research will help to clarify who can fill the prepared safety slot and how they come to do so.

Regardless of the nature of the experience that endows an individual with these fear-inhibiting properties, without doubt that experience is fundamentally different from the conditioning laboratory experience. In the present case, it is highly improbable that participants had prior experience with an electric-shock unconditional stimulus. Despite this, the support stimulus's inhibitory properties transferred to this unique context. Given that transfer of inhibition, even within a laboratory situation, is often limited (Holland, 1991), this level of transfer is impressive.

While this work sheds light on the role of social-support figures as prepared safety signals, more research must be conducted to examine the boundary conditions of these effects, such as the impact of the quality of the relationship with social-support figures on their ability to function as prepared safety stimuli. Additionally, it would be beneficial to collect larger sample sizes in order to examine whether gender or certain individual differences (e.g., attachment style) play a role in the safety effects reported here.

The implications of these findings extend beyond fear learning for social-support targets and suggest consequences for learning fear to other cues as well. As the properties of prepared safety stimuli are, as of yet, unexplored, it is possible that these stimuli might affect the ways in which fear is learned and extinguished. Thus, because of their powerful safety-signal value, prepared safety stimuli might (a) buffer individuals against forming fear associations to novel cues and (b) enhance extinction to fears learned to these novel cues. Future work is necessary to shed light on how prepared safety stimuli might alter basic fear-learning processes.

Showing that social-support figures inhibit other types of fear learning may have important implications for understanding the links between social support and health. Research has consistently shown that individuals who have higher quality social relationships have better physical and mental health (Cohen, 1988, 2004; Cohen, Doyle, Skoner, Rabin, & Gwaltney, 1997; House, Landis, & Umberson, 1988; Thoits, 1995). Although the mechanisms underlying this relationship are unclear, one possibility is that social-support figures, as prepared safety stimuli, reduce the learning of fear and enhance its extinction across various domains, ultimately reducing stress-related physiological reactivity, which may have implications for health. Future work will be needed to explore this possibility.

Altogether, the findings discussed here demonstrate that social-support figures are powerful safety signals that not only do not require participants to receive specific safety training for such signals to inhibit the fear response, but can also potentially lead to more lasting inhibition or extinction of fears—which suggests that social-support figures may be one category of prepared safety stimuli. While further research is required, these results reveal some of the possible characteristics of stimuli in the prepared safety category and offer insight into the ways in which these stimuli might play adaptive and beneficial roles in daily life.

Action Editor

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Author Contributions

E. A. Hornstein and N. I. Eisenberger, with the help and advice of M. S. Fanselow, conceived the idea for the study, developed the theoretical model, and designed the experiments. E. A. Hornstein collected and analyzed the data. E. A. Hornstein, N. I. Eisenberger, and M. S. Fanselow wrote the manuscript. All authors approved the final version of the manuscript for submission.

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

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Supplemental Material

Additional supporting information can be found at http://pss.sagepub.com/content/by/supplemental-data

Note

1. All confidence intervals reported in this article are for the difference between means.

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