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Vicarious Fear Learning: The Role of Empathy


A thesis submitted in partial fulfillment of the requirement
for the degree of Bachelor of Science in Psychology from
The College of William and Mary

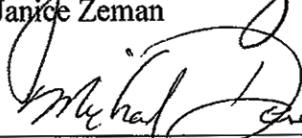
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Vicarious Fear Learning: The Role of Empathy

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Abstract

Fear learning can take place indirectly, by observing others, as well as directly through personal experience. This study aimed to determine whether we could detect indirect – sometimes called vicarious – fear learning in the laboratory, and to examine the influence of trait empathy on the robustness of this learning experience. Deficient empathy features prominently in certain externalizing psychopathologies, and fear learning is theoretically implicated in many psychological disorders, but little research has examined the possible connection between the two. In the present study, we first showed participants ($N = 80$; $M_{age} = 19.1$ years, $SD = 2.1$; 62.5% white) a video of a stranger (called the demonstrator) undergoing a Pavlovian fear conditioning procedure, receiving shocks and loud noises in the context of one of two conditioned stimuli. Next, we presented participants with those same conditioned stimuli. Correlation analyses showed an association between participants' autonomic nervous system reactivity while observing the demonstrator receive aversive stimuli and their own reactivity when presented with the same conditioned stimulus associated with shock in the video. Associations between trait empathy (measured with the Interpersonal Reactivity Index and the Affective and Cognitive Measure of Empathy) and the strength of vicarious fear learning were generally small. Our results suggest the independence of the emotional response and trait empathy during the observation of someone's distress.

Vicarious Fear Learning: The Role of Empathy

As social beings, humans learn readily from each other. One area of social cognition that has been explored in recent psychological research is the understanding of others' emotional states. By observing other humans, individuals can gain insight into their internal affective states which can carry important social information. In this way, humans repeatedly interpret the meaning of others' emotional cues to better understand their own environment (Blair, 2003). This tendency is especially relevant to the development of a healthy repertoire of fears. Direct experience with environmental threats can prove deadly, so using someone else's aversive experience with such threats as a substitute for one's own experience has adaptive value. Vicarious (social) fear learning is the term that describes this indirect learning process. Conceptually, empathy should have an integral role in vicarious fear learning, as people use the emotional cues of others to gather information about their environment throughout the lifespan (Feinman, Roberts, Hsieh, Sawyer, & Swanson, 1992). Yet, little research has sought to examine the connection between empathy and vicarious fear learning. This is problematic because scientific research in this domain could provide an account of social learning processes in the general population as well as clinical groups (e.g., psychopathy) that show aberrant patterns of empathy and social cognition.

Pavlovian Differential Threat Conditioning

Pavlovian threat conditioning (or learning) is a paradigm used to investigate the mechanisms through which fear-related disorders are acquired in humans (Kim & Jung, 2006) and is inspired by the original appetitive conditioning methodology introduced by Ivan Pavlov. In Pavlovian threat conditioning, one initially innocuous conditioned stimulus (CS+) is repeatedly paired with an aversive unconditioned stimulus (US), which automatically activates

unconditioned fear responses (URs; e.g., pain). A second neutral stimulus (CS⁻) is also presented but this stimulus remains nonreinforced, meaning that it is never paired with the aversive US. Since the CS⁻ is never paired with the US, it serves as a conditioned safety cue. After enough paired presentations with the US, the CS⁺ acquires the ability to evoke fear responses itself because of its newly acquired predictive value. This learning process is called acquisition because the subject selectively acquires fear responses to a stimulus that signals an aversive outcome. The term conditioned response (CR) is used to describe the participant's newly developed, automatic reaction elicited by the conditioned stimulus CS⁺ after repeated pairings with the US. Typically, extinction of a CR occurs after repeated exposure to the CS⁺ in the absence of the US. Hence, a new association is learned: the CS⁺ predicts safety. The new association, or memory, then competes with the acquisition memory (CS⁺ predicts US; see Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014).

There are a variety of ways to measure fear responses during threat conditioning procedures. Among the most common are subjective measures of fear (Öhman, Eriksson, & Olofsson, 1975), expectancy ratings of the probability of a US occurring during a given CS presentation (Dawson, Schell, & Bani, 1986; Haesen & Vervliet, 2014), behavioral-expressive measures of fear (e.g., behavioral avoidance; Öst, 1987; Reynolds, Field, & Askew, 2014), and psychophysiological measures of fear (e.g., electrodermal activity, heart rate; Dunsmoor, Mitroff, & LaBar, 2009).

Psychopathology Associated with Aberrant Threat Conditioning

Aberrant threat conditioning patterns are observed consistently in individuals with certain forms of psychopathology. Eysenck (1979) was among the first to propose that fear responses to the CS⁺ versus the CS⁻ would be stronger among anxiety patients compared to controls at both

acquisition and extinction in fear conditioning paradigms. This early view was confirmed by subsequent research. For example, a recent meta-analysis reported that, during extinction, stronger fear responses to the CS+ are found in anxiety patients compared to control participants (Cohen's $d = .35$ [Duits et al., 2015]). In panic disorder (PD), which is classified under the umbrella of anxiety disorders, individuals experience recurrent unexpected panic attacks that occur without any clear triggers (Bouton, Mineka, & Barlow, 2001). Many researchers have put forth evidence that aberrant threat conditioning features prominently in its etiology. One study found that PD patients showed weaker discriminative conditioning (the ability to respond differentially to the CS+ versus the CS-; Cohen's $d = .53$) compared to healthy comparisons during acquisition (Lissek et al., 2009). A substantial body of literature has examined threat conditioning abnormalities in post-traumatic stress disorder (PTSD). Studies generally report stronger electrodermal conditioning during acquisition, as well as slowed extinction of autonomic responding to the CS+ in a PTSD group compared with healthy controls (Blechert, Michael, Vriends, Margraf, & Wilhelm, 2007; Otto et al., 2014).

The threat conditioning literature has also revealed an aberrant threat conditioning profile reliably associated with psychopathy. Cleckley (1988) characterizes psychopathy using a constellation of closely related personality traits, including shallow affect, lack of empathy, and disinhibition. Another key personality trait of psychopathy, which is important as it relates to threat conditioning, is fearlessness (Sylvers, Brennan, & Lilienfeld, 2011). Psychopaths show diminished fear responses during threatening situations instead of the regular pattern of heart rate acceleration and heightened electrodermal activity (EDA) seen in healthy individuals (Hare, Frazelle, & Cox, 1978). When shock is imminent, participants low in psychopathy show a

sharper increase in EDA which occurs earlier and more rapidly compared to high psychopathy participants (Hare, 1965).

Consistent with their profile of weaker electrodermal responding to the CS+, psychopaths exhibit no remarkable activity in the limbic-prefrontal circuit during acquisition (Birbaumer et al., 2005). According to findings from the neuroscience literature, this circuit is thought to underlie conditioned fear (Büchel, Morris, Dolan, & Friston, 1998; Lissek, 2012). Other abnormal neurocircuitry patterns associated with psychopathy are germane for understanding psychopaths' empathic dysfunction. Research implicates right-hemispheric dysfunction in emotional processing deficits, for example (Kosson, Suchy, Mayer, & Libby, 2002; Yang & Raine, 2009). In sum, brain abnormalities help explain both the deficient fear conditioning profile and the impaired empathic ability observed in psychopathy.

Vicarious Fear Learning

According to the Pavlovian conditioning model of anxiety, fear develops as a result of direct experiences with the CS–US contingency and is then able to persist in the absence of the original US. Over time, this etiological account has gained credibility in the anxiety disorders literature (Craske et al., 2014). Although direct conditioning approaches provide a convenient way to study the temporal progression of acquired fear, this account is incomplete (Mineka & Zinbarg, 2006). The shortcoming of the direct conditioning approach to the development of fear is that it does not provide an adequate explanation for the fact that many people with phobias report no history of direct learning experiences (Rachman, 1978). Having observed the inadequacy of the direct conditioning account, Rachman (1977) posited three pathways to fear: direct, observational (also called vicarious), and instructional.

Retrospective studies have highlighted the significance of vicarious fear learning in the development of phobia. Consistent with Rachman's (1977) theoretical account, Öst and Hugdahl (1981) conducted a retrospective study which estimated that, among those with phobia, 17% of participants recall acquiring the phobia indirectly, through vicarious experience. The vicarious pathway is distinct from the direct conditioning pathway in that it requires no direct experience. Instead, one observes someone else's negative experience that occurs in the context of some initially neutral stimulus (e.g., an object, person, situation), and thereby develops a fear of that stimulus.

Vicarious fear learning is theorized to have roots in humans' evolutionary past. Those individuals who needed direct experience to learn to fear a dangerous predator, for example, would have been at a considerable survival disadvantage compared to those who could learn to fear the same predator after indirect, safe, vicarious experience. Vicariously acquired fear is adaptive in situations where it is objectively warranted but maladaptive in situations where imminent threat is absent. Like direct, classically conditioned fear, vicarious fear learning can be studied using Pavlovian principles.

Vicarious fear learning has been studied primarily in mice (e.g., Atsak et al., 2011), monkeys (e.g., Mineka, Keir, & Price, 1980), and humans (e.g., Olsson & Phelps, 2007). The best evidence for the existence of this phenomena comes from the pioneering work of Mineka and colleagues.

Vicarious Fear Learning in Monkeys

A group of investigators led by Mineka set out to test the hypothesis that laboratory-raised monkeys who had no prior experience with snakes could acquire a fear of snakes by observing a conspecific (an animal of the same species) behaving fearfully in their presence. The

researchers conducted their investigation in multiple steps. Data from the first experiment showed that laboratory-reared young monkeys, who had never been exposed to real or toy snakes, did not exhibit significant avoidance responses to them (Mineka et al., 1980). In the second experiment of the study, the researchers paired each young laboratory-raised monkey with a parent wild monkey. The parent wild monkeys served as models while the young monkeys were observers. Several sessions took place in which the young monkeys observed the parent monkeys interact with real or toy snakes. Following observation, the laboratory-raised monkeys displayed robust fear and behavioral avoidance responses in the presence of real and toy snakes when encountering them alone. Planned follow-up tests conducted 3 months after the final observation sessions showed that the learned fear was remarkably persistent. One of these tests revealed that observer monkeys spent significantly less time with a toy snake during the follow-up test than during the first test of fear acquisition conducted after observation (Mineka, Davidson, Cook, & Keir, 1984). Mineka's research legitimated claims surrounding vicarious fear learning, taking it from a nebulous area of intrigue to a new, rigorous area of study encompassing basic methods that could be applied across species.

Vicarious Fear Learning in Humans

Despite the modern ethical limitations that prohibit researchers from inducing potent, lasting fears in humans, the human vicarious fear learning literature is growing and incorporates a wide range of related phenomena, such as parental modeling and social cognition. Berger (1962) was among the first to examine vicarious fear learning in humans. He arranged for a performer (i.e., confederate) to receive a shock and move his arm upon hearing a buzzer sound. The results showed the most pronounced EDA in observers who saw the performer both receiving a shock and moving the arm in response. Participants in other groups who observed

only one of those actions evinced lower electrodermal reactivity. In a similar vein, Bandura and Rosenthal (1966) designed an experiment to see whether a mild fear could be conditioned in humans through observation. They found that conditioned emotional responses could be transmitted vicariously, but that transmission was most effective when physiologically induced arousal was manipulated to be mild rather than high.

Vicarious fear learning as an area of study has benefitted from the inclusion of related phenomena, like early modeling and learning experiences. According to Rapee's (2001) model of the development of anxiety disorders, anxious behaviors are readily acquired following children's observation of parents behaving anxiously in the presence of specific stimuli. In support of Rapee's model, one study found that children whose parents exaggerated pain during an uncomfortable cold pressor task reported higher anxiety before undergoing the same cold pressor task themselves (Boerner, Chambers, McGrath, LoLordo, & Uher, 2017).

Early experiences are important in modifying humans' collections of malleable fears (Ollendick, King, & Muris, 2002). The high prevalence of both vicarious fear learning (Öst, 1987) and specific phobia in adolescents (16%) relative to older adults (3% – 5%) attests to the relevance of vicarious fear learning for younger populations (5th ed.; *Diagnostic and Statistical Manual of Mental Disorders [DSM-5]*; American Psychiatric Association, 2013). While especially relevant to adolescents, adults also rely on social experiences to shape views of their surroundings (Adolphs, Baron-Cohen, & Tranel, 2002). A number of studies have contributed to a working characterization of the processes and influences involved in vicarious fear learning.

A foundational and well-supported idea in vicarious fear learning is that facial fear expression wields the same physiological response-eliciting power of a US (Olsson & Phelps, 2004; Vaughan & Lanzetta, 1980). Even masked (i.e., presented so briefly as to remain outside

conscious awareness) facial fear displays lead to unconscious elicitation of electrodermal responses as compared to masked happy faces (Esteves, Parra, Dimberg, & Öhman, 1994). Primitive bottom-up processes such as these provide the scaffolding for vicarious fear learning which connects a CS with a fearful facial US. Other higher-level cognitive factors which affect the interpretation of emotional stimuli should also have an important role. A range of variables, including the relationship of the observer to the social model (Golkar, Castro, & Olsson, 2015), one's bias towards threatening information (Cisler & Koster, 2010), and individual variation in empathic ability (Pfabigan et al., 2015) may produce additive effects on vicarious fear learning.

Empathy's Possible Influence on Vicarious Fear Learning

The most common definition of empathy is “an affective response more appropriate to someone else's situation than to one's own” (Hoffman, 1990, p. 48). However, recent research has deviated from this common definition to define empathy as the ability to share and understand a target's affective states (Zaki, 2014). There seems to be agreement among researchers that at least three primary aspects of empathy exist: 1) an affective response to another person which may entail sharing that person's emotional state, 2) a cognitive capacity to take the perspective of the other person, and 3) some self-regulatory and monitoring mechanisms that modulate inner states (Decety & Moriguchi, 2007).

Empathy is implicated in several mental disorders. In the *DSM-5* (American Psychiatric Association, 2013), a lack of empathy serves as a diagnostic criterion for antisocial personality disorder (“lacks empathy, is unwilling to recognize or identify with the feelings and needs of others” [p. 670]) and narcissistic personality disorder (“a pervasive pattern of grandiosity, need for admiration, and lack of empathy” [p. 669]). Processes shaped by humans' evolutionary past underlie the experience of empathy.

From an evolutionary perspective, the adaptive value of empathy stems from its communicatory value. Facial expressions of emotion can be thought of as messages which tell conspecifics about the hazards associated with a given environment (Blair, 2003). Empathy can be conceptualized as a receiver picking up emitted emotional signals from conspecifics. The individuals with the more receptive and accurate receivers should learn more safely and effectively about the hazards of their environment. The application to vicarious fear learning is that those who are more empathic should learn more accurately about environmental threats.

Bottom-up processes collectively represent a component which contributes to empathy. These processes are automatic, immediate, and are enabled by the perception of pain in others. Emotion contagion is one example of such a bottom-up process. In emotion contagion, an organism mimics another's emotion automatically, independent of the personal significance of that affective state to the observing organism (Hatfield, Cacioppo, & Rapson, 1994; Sonnyby–Borgström, 2002).

Emotion contagion may provide the foundation for empathy, as demonstrated in an experiment by Dimberg and colleagues (2000). In this experiment, participants were presented with target stimuli which were masked (i.e., presented outside of conscious awareness). These target stimuli consisted of happy, angry, or neutral faces. Following each presentation, a neutral face was displayed as the masking stimulus for 5 seconds. Small electrodes recorded facial muscle movements during these presentations, revealing that participants' facial musculature mimicked that of the target stimuli faces. In addition, affective synchrony was detected as participants reported experiencing emotions that corresponded with those of the target faces they observed non-consciously.

The human imitation system, guided by the function of mirror neurons, has informed new speculation about the neural basis of empathy. The mirror neuron system may provide an organism with enhanced sensitivity to certain categories of motor information, such as facial expressions (Keysers & Gazzola, 2006; Preston & de Waal, 2002; Rizzolatti & Craighero, 2004). Mirror neurons, then, have the role of translating salient social information into a form of neural activity more easily understood by the observing organism. Other evidence supports this connection, such as recent functional imaging studies that have confirmed the existence of a shared neural circuit that underlies both the experience of one's own pain and the observation of another's pain (Jackson, Rainville, & Decety, 2006; Yamada & Decety, 2009). Although more research in this area is needed, promising connections are already being made between this bottom-up neurological process and forms of severe psychopathology like schizophrenia (McCormick et al., 2012).

Empathy may also operate in a top-down manner. This side of empathy is sometimes called perspective taking and involves higher-order abilities than does bottom-up empathy (Ruby & Decety, 2001). That the types of empathy just described are truly distinguishable is evidenced by the developmental trajectory of children who may experience empathic affect without an explicit cognitive understanding of the suffering of another individual (Bengtsson & Johnson, 1992).

The bottom-up and top-down processes in empathy have lead researchers to identify two general types of empathy: affective and cognitive. Affective empathy describes the observer's relatively automatic emotional responses that are triggered by social cues whereas cognitive empathy describes the conscious, cognitive ability to understand another person's emotions. The distinction between these two dimensions of empathy has been supported experimentally, as

researchers have found that affective reactions to others' emotions can be evoked before conscious identification of others' emotions occurs (Dimberg & Öhman, 1996). Data from populations with deficient affective, but not cognitive empathy (e.g., psychopaths), also support the distinction between the two related but separable constructs (Blair, 2005; Zaki, Bolger, & Ochsner, 2008).

Despite their differences, affective and cognitive empathy are both purported to be positively related to prosocial behaviors (Ang & Goh, 2010). However, the research on affective empathy has provided several findings which show its divergence from cognitive empathy as well as its unique explanatory value. For example, Shechtman (2002) reported that physically aggressive boys were lower in their levels of affective empathy than non-aggressive boys but did not differ from non-aggressive boys in their levels of cognitive empathy. Likewise, Cohen and Strayer (1996) found reduced affective empathy in clinically aggressive adolescents compared to healthy adolescents in a behavioral measure assessing the concordance of youth emotions with the emotions expressed by characters in a videotape. Research has also examined the differential contributions of affective and cognitive empathy in internalizing psychopathology. One study reported significant, small to medium effect sizes for affective empathy, such that it was correlated positively with girls' and boys' affective, anxiety, and ADHD problems in a sample of adolescent inpatients (Gambin & Sharp, 2016). Cognitive empathy, however, was not significantly correlated with any of those psychopathological symptoms in girls or boys; instead, it was significantly negatively correlated with conduct problems for only girls.

Non-clinical psychopathy has also been examined in relation to affective empathy. Those high in psychopathic traits tend to report inappropriate, dissonant affect in response to sad images (Ali, Amorim, & Chamorro-Premuzic, 2009). Though psychopaths are profoundly

deficient in affective empathy, they show no deficiency in cognitive empathy (Blair, 2005). The dimensionality of empathy is important to appreciate when considering empathy's effects on other outcomes like vicarious fear learning.

Mineka and Cook (1993) used the behaviorist framework to posit that a model's fear display in the presence of a fear-provoking object serves as an unconditioned stimulus (US) that elicits an unconditioned fear response (UR) in the observer, leading to a conditioned fear response (CR) in the presence of the same object at a later time. This framework was experimentally supported with the finding of a strong correlation between the level of disturbance exhibited by a model and observer during observational conditioning. In addition, observers' disturbance behaviors during conditioning predicted their own posttest and follow-up disturbance behaviors. These data imply that during a vicarious fear learning procedure, an individual's unconditioned response to the social stimulus of a demonstrator's discomfort is a proxy for the strength of learning about the conditioned stimulus. Differences in individuals' empathy may determine the strength of the relation between the observed social US and later manifested CR in the presence of the CS+. The most empathic organisms have the most information to guide their responding during subsequent tests of their learning.

In a test of the above-mentioned ideas, Olsson and colleagues (2016) conducted an experiment which examined whether empathic appraisals and trait empathy affect vicarious fear learning. The experiment consisted of two phases: observation and test. During the observation phase, participants observed a video of a stranger (called the demonstrator) undergoing a Pavlovian fear conditioning procedure in which an electric shock was presented in the context of one of two conditioned stimuli (both colored squares). In the test phase, the experimenters presented the same conditioned stimuli to the participants while they were under the impression

they would receive shocks in the context of the same conditioned stimulus (CS+) of the observation phase, although this never occurred. Throughout the study, participants' EDA was monitored and used as an index of the social unconditioned response (i.e., involuntary physiological response to seeing the demonstrator's distress) and the conditioned fear response (i.e., selective physiological response to the CS+).

To manipulate empathy, participants were divided into three groups that received differing empathy appraisal instructions. The high-empathy group was told to amplify their empathic response while watching the video whereas the low-empathy and no-instruction groups were told to limit their empathic response or nothing, respectively. Specifically, the high-empathy group was told to pay close attention to the discomfort of the demonstrator who rated the shocks as painful. Participants in the low-empathy group were told that the demonstrator hardly noticed the shocks and that they should only pay attention to the demonstrator's expressions in order to understand the relationship between the conditioned stimuli and the shocks. Lastly, the no-instruction group was given no instructions regarding the demonstrator's experience or empathic appraisal. Analyses revealed that only the high-empathy group showed moderate positive correlations between the unconditioned response during the observation phase, trait empathy, and the conditioned fear response during the test phase. Although the study produced new insights regarding empathy's interesting role in vicarious fear learning, a full picture of the influences on vicarious fear learning remains incomplete as the authors did not include a detailed assessment of empathic ability.

The Present Study

The present study sought to replicate Olsson and colleagues' (2016) study. That is, we aimed to replicate the correlations between the social unconditioned response of the observer, the

conditioned fear response, and trait empathy. To meet this goal of replication, we recruited a sample of college students who received the same empathy-amplifying instructions. This sample selection allowed for adequate comparison of results from past research in this domain that has also recruited college student samples (Golkar, Castro, & Olsson, 2015; Olsson et al., 2016). We also set out to examine vicarious fear learning in a more rigorous manner than Olsson and colleagues' (2016) study. One way we deepened rigor was by asking participants to indicate their subjective fear, arousal, and valence to each CS following each experimental phase (observation and test). Acknowledging the wealth of empathy self-report measures used in current research, we opted to include two questionnaires that addressed empathy from different theoretical frameworks, including the aforementioned affective and cognitive framework.

Our primary hypothesis was that the social unconditioned response measured during the test phase would correlate positively with the conditioned fear response during the test phase. In addition, we hypothesized that trait empathy would correlate with the unconditioned and conditioned fear response, such that those who are higher in empathy would exhibit stronger responses. We also anticipated correlations among our post-phase self-report measures. After a given phase, we anticipated that ratings of fear, arousal, and valence to the CS+ would covary significantly. For the demonstrator variables, we anticipated a positive correlation between the extent of attention paid to the demonstrator's experience during the observation video and the conditioned fear response during the test phase.

Method

Participants

Eighty William & Mary psychology students (52 female; $M_{age} = 19.1$ years, $SD = 2.1$; 62.5% white) completed the experimental session and were compensated with course credit.

Students were eligible if they were over the age of 18 and had not participated in any other studies sponsored by the research lab. Due to a data processing error, EDA data was unavailable for the observation phase of the first 15 participants. In addition, one participant declined to participate in the test phase. We excluded four participants from the analysis based on EDA levels that exceeded 2.5 *SD* from the mean during the observation or test phase. After these exclusions, the final sample was 62 participants (41 female; $M_{age} = 19.1$ years, $SD = 2.3$; 58.1% white) for EDA analyses related to the observation phase, 76 participants (49 female; $M_{age} = 19.1$ years, $SD = 2.2$; 63.2% white) for EDA analyses related to the test phase, and the full 80 participants for analyses including only self-report data. All participants provided written informed consent and were informed that they could decline to participate at any time.

Stimuli

The observation and test phases of the experiment were presented using E-Prime software (Version 2.0; Psychology Software Tools, Inc., Pittsburgh, PA). Our program displayed two colored geometric objects one at a time against the white background of the computer screen. For all participants, a green cube represented the CS+ while a blue disc represented the CS-. During the observation phase, the CS+ was associated with a shock and loud noise presentation to the demonstrator while the CS- functioned as the “safety” stimulus that was never associated with a shock or loud noise presentation to the demonstrator.

Presenting the observation phase required the creation of two videos, so we recorded videos of two different demonstrators undergoing a Pavlovian fear conditioning procedure using the above-specified CSs (see Figure 1a). Later, each video was matched with participants’ gender such that male participants watched the male demonstrator while female participants watched the female demonstrator. The videos showed the demonstrator sitting calmly in front of

a computer screen with “shock” electrodes attached to the forearm and headphones over the ears. The demonstrator watched as the CS+ and CS– were presented five times each for 10 s in pseudorandomized order (neither stimulus was presented more than twice consecutively). Each trial was interleaved with an intertrial interval that ranged from 10 to 14 s ($M = 12$ s, $SD = 1.5$). In both videos, three of the five CS+ presentations co-terminated with a “shock” and loud noise administration. While the demonstrators did actually receive loud noise presentations, they did not receive any real electric shocks. Upon hearing the loud noise, demonstrators feigned physical discomfort by wincing and jerking the arm up upon receiving the “shock.” None of the CS– presentations co-terminated with a “shock” or loud noise.

During the test phase (see Figure 1b), participants were presented with the same CSs they observed in the observation phase. As in a prior study (Olsson et al., 2016), no shocks or loud noises were delivered to the participants during the test phase to ensure that the only source of contingency learning was social. Each CS was presented five times in pseudorandom order (i.e., no more than two consecutive presentations of the same CS) for 10 s. These presentations were interleaved with an intertrial interval lasting from 10 to 14 s ($M = 12$ s, $SD = 1.5$).

We recorded EDA during both the observation and test phases and measured it with disposable electrodes attached to the medial phalanges of the first and second digits of the participant’s left hand. The EDA signal was amplified and recorded with a BIOPAC MP150 connected to a PC that continuously recorded at a rate of 2,000 samples per second. Subsequent EDA data analysis was conducted with AcqKnowledge software (BIOPAC Systems, Inc., Goleta, CA).

Design and Procedure

Once participants read and signed the informed consent document, EDA electrodes were attached. The participants then completed a set of questionnaires that was administered using Qualtrics software. After completing the surveys, participants sat quietly during a 2-minute baseline period, then received instructions regarding the observation phase. Specifically, they were told that they would watch a video of a person (the demonstrator) receiving shocks and loud noises. They were also told that the demonstrator rated the shocks and loud noises as “painful.” In our effort to replicate the effect of an empathic appraisal manipulation in Olsson et al. (2016), participants were instructed to do their best to imagine the pain and feel the discomfort the demonstrator was experiencing. Once the video ended, participants provided post-phase ratings.

After providing these ratings, participants were told that they would go through the same learning procedure they had just witnessed, receiving shocks and loud noises in the context of the same object associated with that contingency as in the video. The experimenter then attached “shock” electrodes and headphones in the same manner as in the observation phase video. The “shock” electrodes we used are designed for electrocardiography but were still convincing to our participants who evinced high EDA during the test phase overall. After presentations of the CS+ and CS– concluded, participants again provided post-phase ratings.

When participants finished with those ratings, all electrodes and the headphones were removed. Finally, the experimenter debriefed the participant, explaining why the participant had been misled into believing receive aversive stimuli would be received.

Self-Report Measures

Empathy

Interpersonal Reactivity Index (IRI)

The IRI (Davis, 1983) is a 28-item self-report measure of empathy. It assesses multiple cognitive and affective components of empathy with its four-factor structure. Participants use a 5-point scale (0 = *does not describe me at all*, 1 = *does not describe me*, 2 = *describes me somewhat*, 3 = *describes me well*, 4 = *describes me very well*) to respond to each statement. Seven items make up each of the four subscales: Perspective-Taking (PT; “*I try to look at everybody’s side of a disagreement before I make a decision*”), Fantasy (FS; “*I really get involved with the feelings of the characters in a novel*”), Empathic Concern (EC; “*I often have tender, concerned feelings for people less fortunate than me*”), and Personal Distress (PD; “*In emergency situations, I feel apprehensive and ill-at-ease*”). As a well-established measure, the IRI has been validated in diverse populations (Beven, O’Brien-Malone, & Hall, 2004; Hawk, et al., 2013; Péloquin & Lafontaine, 2010). Internal consistency for the IRI scales ranged from $\alpha = .73$ to $\alpha = .78$ in the current study.

Affective and Cognitive Measure of Empathy (ACME)

The ACME (Vachon & Lynam, 2016) is a 36-item self-report measure of empathy. It provides better prediction of aggressive behavior compared to existing empathy measures (Vachon, Lynam, & Johnson, 2014) and features three subscales: Cognitive Empathy (COG; 12 items; “*I can tell when someone is afraid*”), Affective Resonance (RES; 12 items; “*It makes me feel good to help someone in need*”), and Affective Dissonance (DIS; 12 items; “*I love watching people get angry*”). Internal consistency for the ACME scales ranged from $\alpha = .76$ to $\alpha = .86$ in the current study.

Post-Phase Ratings

Once the observation phase ended, participants provided several ratings on a 7-point scale. First, they were asked to indicate the extent to which they imagined the experience of the

demonstrator (vicarious imagining) and the extent to which they vicariously felt the demonstrator's discomfort (vicarious discomfort). After both the observation phase and the test phase ended, participants reported their fear, valence, and arousal with respect to each conditioned stimulus. Higher ratings reflected more of each construct.

EDA Data Analysis

Initial processing of EDA data consisted of resampling the waveform to 200 samples/second, median smoothing, and low-pass filtering. Data abnormalities were corrected as part of these initial processing steps (Lykken & Venables, 1971).

In line with similarly designed studies (Olsson et al., 2016; Olsson & Phelps, 2007), we processed EDA data for each trial as the largest as the largest base-to-peak amplitude difference in skin conductance (in microsiemens; μS) occurring during the specified interval. For the observation phase, that interval was 0.5 s to 4.5 s after onset of aversive stimuli to the demonstrator during reinforced CS+ presentations. We used the corresponding window for nonreinforced CS+ presentations and CS- presentations. For the test phase, we used the interval 0.5 s to 4.5 s following the onset of the CS+ and CS-.

Our minimal response criterion was 0.02 μS . Any skin conductance response not meeting this level was scored as 0. Once these data were collected, they were square-root transformed then divided by each participant's maximal amplitude difference, separately for the test and observation phases, thereby removing variation arising from individual variation in sweat gland characteristics.

Analytic Plan

After performing the initial EDA data processing steps, we performed further calculations to attain our variables of interest: the social unconditioned response and the conditioned fear

response. To calculate the unconditioned response during the observation phase, we averaged the EDA data from the presentations of the reinforced CS+ and subtracted the averaged EDA data from CS- presentations. To calculate the conditioned fear response during the test phase, we averaged the EDA data from the presentations of the CS+ and subtracted the averaged EDA data from the CS- presentations, excluding the first trial of each in the mean calculations so as to omit a possible orienting response.

Next, we conducted a one-way repeated measures ANOVA to determine whether our sample had more responsivity when witnessing the demonstrator receive a shock and loud noise presentation in the context of the CS+ during the observation phase versus seeing the demonstrator experience no aversive stimuli in the presence of the CS+ or CS-. Next, we conducted a paired samples t-test to examine differences in responding to the CS+ versus the CS- during the test phase. Finally, we conducted Pearson correlations among our self-report variables and the unconditioned and conditioned response.

Results

Fear Acquisition

First, we conducted a one-way repeated measures ANOVA to determine whether our sample had more responsivity when witnessing the demonstrator receive a shock and loud noise presentation in the context of the CS+ during the observation phase versus seeing the demonstrator experience no aversive stimuli in the presence of the CS+ or CS-. Stimulus type, consisting of three levels: reinforced CS+ presentations, nonreinforced CS+ presentations, and CS- presentations, served as the independent variable. Electrodermal activity served as the dependent variable. As demonstrated in Figures 2 and 4, the analysis revealed a main effect of stimulus type during the observation phase, $F(1.44, 88.00) = 112.03, p < .001, \eta_p^2 = .65$. Follow-

up Bonferroni-corrected t-tests showed that mean EDA for reinforced CS+ presentations was greater than for both nonreinforced CS+ presentations, $t(61) = 10.69, p < .001$, and CS- presentations, $t(61) = 12.23, p < .001$. Nonreinforced CS+ presentations and CS- presentations did not differ, $t(61) = .18, p = .86$.

A paired samples t-test also revealed a main effect of stimulus type during the test phase, $t(75) = 4.05, p < .001, 95\% \text{ CI} [.11, .31], d = .52$, such that presentations of the CS+ were associated with larger amplitude changes in EDA (Figure 3 and 5) than presentations of the CS-.

The Unconditioned and Conditioned Response

Next, we examined whether the unconditioned response to the social US during the observation phase was associated with the conditioned fear response to the CS+ during the test phase. Using EDA data for this analysis, we found that the social unconditioned and conditioned fear responses correlated positively ($r = .39, p = .002$; see Figure 6 for scatterplot).

Self-Reported Empathy

To investigate our hypothesis related to the potential effects of trait empathy, we conducted analyses to find out whether the subscales of our empathy measures modulated the unconditioned and conditioned responses. In light of concerns about the construct validity of the Fantasy and Personal Distress scales of the IRI (Vachon & Lynam, 2016), we decided to use only the Perspective Taking and Empathic Concern scales to examine the relation of empathy to our vicarious fear learning response variables. The analysis did not yield evidence for relations between Perspective Taking, Empathic Concern, and the unconditioned response. However, as seen in Table 1, we did detect a statistically significant correlation between EC and the conditioned fear response ($r = .24, p = .034$), such that higher levels of empathic concern were associated with heightened EDA when presented with the CS+ versus the CS-.

We also explored the relations between the ACME subscales and the unconditioned and conditioned response. As Table 1 shows, we found weak, non-significant correlations between the ACME subscales and the vicarious fear learning response variables. The strongest correlation we found was between the Affective Dissonance subscale of the ACME and the conditioned fear response ($r = .18, p = .12$), such that less affective dissonance (i.e., higher empathy) was associated with a larger conditioned fear response.

Post-Phase Variables

Table 2 summarizes the results of Pearson correlations aimed to determine the relations between empathy and EDA levels during the observation phase and fear, arousal, and valence with respect to the CS+ reported after the observation and test phases. Aside from the expected correlations between fear, arousal, and, valence to the CS+, we found that these variables also correlated significantly with the demonstrator empathy variables. For example, both fear and arousal in the context of the CS+ after observation was positively correlated with participants' vicarious discomfort ($r = .34, p = .002; r = .28, p = .013$) and vicarious imagining ($r = .30, p = .008; r = .42, p < .001$). Fear to the CS+ after the observation phase correlated positively with fear ($r = .24, p = .033$) and arousal ($r = .28, p = .012$) to the CS+ after the test phase. Valence for the CS+ after observation correlated negatively with the conditioned fear response ($r = -.25, p = .03$). Vicarious discomfort correlated positively with the conditioned fear response ($r = .23, p = .046$). We also observed significant correlations between self-reported fear and arousal for the CS+ after the test phase and the conditioned fear response ($r = .31, p = .006; r = .25, p = .027$).

Discussion

Vicarious fear learning, which occurs when one learns to fear an object, situation, or person by observing someone else's emotional reaction to it, represents one of the many

consequences of humans' historic reliance on the emotional cues of others to guide their own behavior. Particularly in the context of learned fear, indirect learning is often a safer and more efficient substitute for direct learning. Organisms that need direct experience with dangerous predators, for example, are unlikely to pass on their genes to future generations.

Since humans differ in their levels of attention to and understanding of the emotional states of others, we would expect that people exhibit differing tendencies to vicariously acquire fear. Although neuroscientific findings have shed light on the pathways responsible for producing the experience of vicarious pain (Jeon et al., 2010), we have a comparatively limited understanding of the learning that may result from such transmission.

In the current study, we enlisted empathy as the individual difference variable which could hold predictive value, telling us who is most likely to develop a fear as a result of this stable ability to understand and share the feelings of another individual (in our study, the demonstrator). We measured empathy with well-established (IRI) and novel (ACME) measurement techniques.

Replicating a past finding, we showed that participants' physiological reactivity while observing the aversive learning experience of another individual correlated positively with the strength of their vicarious fear learning evinced during a subsequent test. This finding is consistent with past research positing that the sight of a conspecific receiving painful stimuli has the potency of an unconditioned stimulus which, by itself, can elicit an unconditioned response on the part of the observer (Blair, 2005; Esteves et al., 1994). The correlation we found ($r = .39$, $p = .002$) is comparable to that of Olsson et al. ($r_s = .51$, $p < .05$; 2016) for participants who were given empathy amplifying instructions.

Although trait empathy is conceptually related to humans' ability to learn from others, we found no such effect. Instead, we found weak and nonsignificant associations between our empathy self-report measures and the unconditioned and conditioned response. Our findings conflict with prior research that found moderate associations between emotional empathy and the unconditioned ($r_s = .41, p < .05$) and conditioned response ($r_s = .45, p < .05$; Olsson et al., 2016). However, we note that in this same study, participants who were given no instructions regarding empathic appraisal and those who were told to diminish their empathy towards the demonstrator showed no influence of trait empathy on the unconditioned and conditioned response. In that study, both those no-instruction and low-empathy groups showed weak, non-significant associations between emotional empathy and the conditioned response ($r_s = -.24$; $r_s = -.26$, respectively). Collectively, these findings suggest that relations between our variables of interest is highly context dependent.

We believe our findings in this area should be interpreted in light of the possibility that nonconscious physiological reactivity may bear little relation to one's self-reported empathic tendencies. We also accept the possibility that one's empathic ability can be adjusted (Ang & Goh, 2010; Marshall, 1999) in a manner that produces a disparity from one's physiological responding to the emotions of another individual. It is also possible that that synchrony between one's conscious empathic ability and one's nonconscious physiological emotion sharing with another individual may never have been synchronized from the outset. The discord between our self-report and physiological measures leads us to welcome continued investigation in the area of affective empathy. Psychological assessment of empathy would benefit from concise self-report measures that accurately assess one's visceral response to another individual's distress.

Among our post-observation and test self-report variables, we found several interesting relations. The inverse relation between valence for the CS+ and the conditioned fear response is interesting, considering that we observed no notable associations between fear and arousal for the CS+. This represents an intriguing finding that we interpret in light of past research that has found evidence for the existence of separate but correlated representations of valence and arousal in the brain for negative and positive stimuli (Viinikainen et al., 2010). It could be the case that, in the context of observationally conditioned fear, valence representations exert more influence on future fearful responding than fear and arousal during observation. Another prospective relationship emerged between vicarious discomfort and imagining such that those who reported more of these experiences showed a heightened conditioned fear response. These relationships are counterintuitive since neither of these demonstrator variables were meaningfully related to the unconditioned response as we expected. The self-report data we collected post observation phase speak to a latent effect of observing a conspecific's distress that does not appear until presented with the same fear-provoking stimuli. Still, the associations we observed were weak (both under $r = .25$).

Limitations and Future Directions

There are several key limitations of this study. We noted previously that in recording the observation videos, our demonstrators merely feigned the reception of electric shocks. This could present a weakness in our study as past research has indicated that these insincere reactions provoke smaller EDA than the reactions preceded by genuine shocks (Berger, 1962; Olsson & Phelps, 2007). However, we believe any attenuation in EDA was likely outweighed by the simultaneous, genuine presentation of a loud noise stimulus to the demonstrator which was

followed by a genuine expression of pain. Although a definite limitation, the observed association between the unconditioned and conditioned response suggests a negligible effect.

The current study was informed by the recent work of Olsson et al. (2016). Our study closely resembles theirs, but it also deviates in notable ways. Perhaps the largest deviation is that we were unable to use the same empathy self-report measure (i.e., it was no longer available from the developer; A. Mehrabian, personal communication, March 7, 2016). Although there is no shortage of well-validated measures of empathy in current research, this methodological difference precluded an ideal, direct comparison of our results. Our use of two measures of empathy that purport to examine the same emotional component counteracted this limitation.

Another deviation from Olsson et al. (2016) is that we did not use separate empathy groups. All participants in this study were told to enhance their empathic response to the demonstrator. Our decision was informed by the findings of that study which reported a relationship between empathy, the unconditioned response, and the conditioned response only in the high empathy group. Still, we maintain that the effects produced through empathy manipulations could be a constructive area of future research. Already, researchers have found effects stemming from the racial status of the demonstrator. In one study, participants exposed to an in-group demonstrator acquired a more robust conditioned response than those exposed to an out-group demonstrator (Golkar et al., 2015). Empathy can be manipulated in other creative, ecologically valid ways as well, such as by providing participants with fabricated information about the prosocial (e.g., charitable giving) or antisocial (e.g., stealing from others) acts the demonstrator has committed. Future research would benefit from the analysis of the effects brought about by such manipulations.

We also recognize that the above-described effect of racial status may have influenced our study. Our study, which had a 62.5% white sample, made use of two white demonstrators. At the same time, recording additional videos of demonstrators with a different racial status would have introduced more variation in what each participant saw. The level of distress displayed by the demonstrator matters as it relates to the conditioned fear response, and adding other demonstrators means that we could have created more variation in the level of distress that participants see, depending on the demonstrator they observed.

Our sample, comprised of university students, may have weakened the conclusions we can draw from our study. Just as the fear conditioning literature often compares samples of anxiety patients to healthy controls (Lissek et al., 2005), vicarious fear learning research would benefit from the comparison of individuals with abnormally low empathy levels to individuals with normal to high empathy levels. Future studies could use an empathy screener to selectively recruit individuals who are low and/or high in empathy for comparison.

While vicarious fear learning is relevant across all development periods, it is most relevant in childhood and adolescence when rates of phobia development through the vicarious pathway are highest (Öst, 1987). According to the *DSM-5*, the 12-month prevalence rate of specific phobia is 7% – 9% in adults which compares to 16% of adolescents (American Psychiatric Association, 2013). Because vicarious fear learning and phobias generally are more common in adolescents, the investigation of this phenomenon during that developmental period may have the most value (Askew & Field, 2008). In addition, phobia and vicarious fear learning prevalence differs by gender. The prevalence of specific phobia is higher in women and women's greater sensitivity to fearful facial expressions makes them more vulnerable to developing fears through the vicarious pathway (McLean & Anderson, 2009). To the extent

possible, future research should take these prevalence considerations into account when recruiting samples.

In this study, we have shown that changes in EDA during the observation of someone undergoing a Pavlovian fear conditioning procedure relates positively to the strength of their vicariously learned fear expressed during a subsequent test. This positive association buttresses previous findings which have argued that the sight of a distressed conspecific can serve as an unconditioned stimulus. In contrast with previous research, we observed negligible effects of empathy on the unconditioned and conditioned response.

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Table 1*Means, Standard Deviations, and Intercorrelations between Trait Empathy Variables and the Unconditioned and Conditioned Response*

<i>Measure</i>	<i>Mean</i>	<i>SD</i>	1	2	3	4	5	6	7
1. IRI: PT	3.99	.59	–						
2. IRI: EC	4.11	.77	.47**	–					
3. ACME: COG	3.87	.51	.30**	.28**	–				
4. ACME: RES	4.41	.42	.41**	.75**	.35**	–			
5. ACME: DIS	4.14	.46	.20	.38**	.10	.48**	–		
6. UR	.50	.32	–.20	.06	–.17	–.12	–.03	–	
7. CFR	.21	.45	–.18	.24*	.06	.12	.18	.39**	–

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

Note. $N = 80$ for all correlations between the IRI and ACME subscales. $N = 62$ for all correlations involving the UR. $N = 76$ for all correlations involving the CFR (except the correlation with the UR). Higher scores on each IRI and ACME subscale reflect greater empathy. IRI = Interpersonal Reactivity Index; PT = Perspective Taking; EC = Empathic Concern; ACME: Affective and Cognitive Measure of Empathy; COG = Cognitive Empathy; RES = Affective Resonance; DIS = Affective Dissonance; UR = Social Unconditioned Response (Observation Phase); CFR = Conditioned Fear Response (Test Phase).

Table 2

Means, Standard Deviations, and Intercorrelations between Self-Reported Fear, Arousal, and Valence to the CS+ and the Unconditioned and Conditioned Response

<i>Measure</i>	<i>Mean</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9	10
1. OBS: Fear	3.51	1.68	–									
2. OBS: Arousal	4.91	.92	.42**	–								
3. OBS: Valence	2.65	1.15	–.37**	–.46**	–							
4. DEM: Discomfort	5.73	.95	.34**	.28*	–.47**	–						
5. DEM: Imagining	4.91	1.39	.30**	.42**	–.43**	.39**	–					
6. TEST: Fear	3.23	1.80	.24*	.13	–.10	.15	.09	–				
7. TEST: Arousal	4.90	1.36	.28*	.17	.04	.05	.12	.62**	–			
8. TEST: Valence	3.13	1.36	–.10	–.06	.01	–.05	–.10	–.58**	–.66**	–		
9. UR	.50	.32	–.01	–.03	.03	.18	–.02	.10	–.01	.05	–	
10. CFR	.21	.45	.09	.14	–.25*	.23*	.22	.31**	.25*	–.22	.39**	–

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

Note. $N = 80$ for all correlations not involving the UR and CFR. $N = 62$ for all correlations involving the UR. $N = 76$ for all correlations involving the CFR (except the correlation with the UR). OBS = Observation Phase; DEM = Demonstrator; UR = Social Unconditioned Response (Observation Phase); CFR = Conditioned Fear Response (Test Phase).

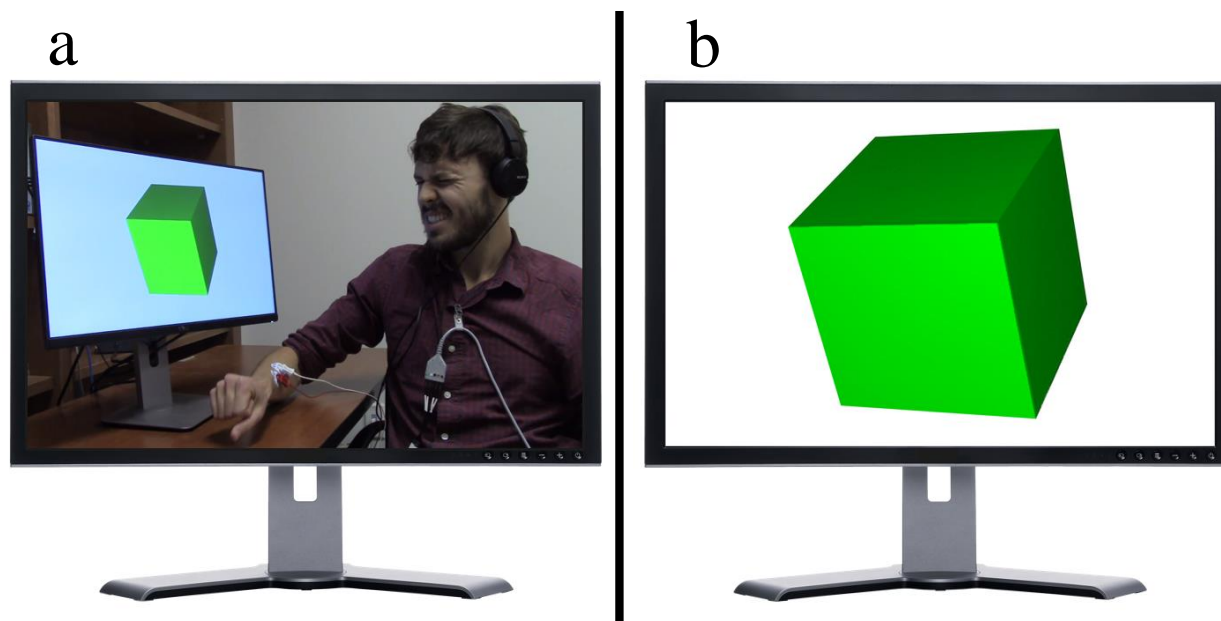


Figure 1. During the observation phase (a), participants observe the demonstrator receive shocks and loud noises in the context of the CS+ but not the CS-. During the test phase (b), we present participants with the same conditioned stimuli they observed during the observation phase. Participants expect and are told they will receive shocks and loud noises in the context of only the CS+ but never receive such stimuli.

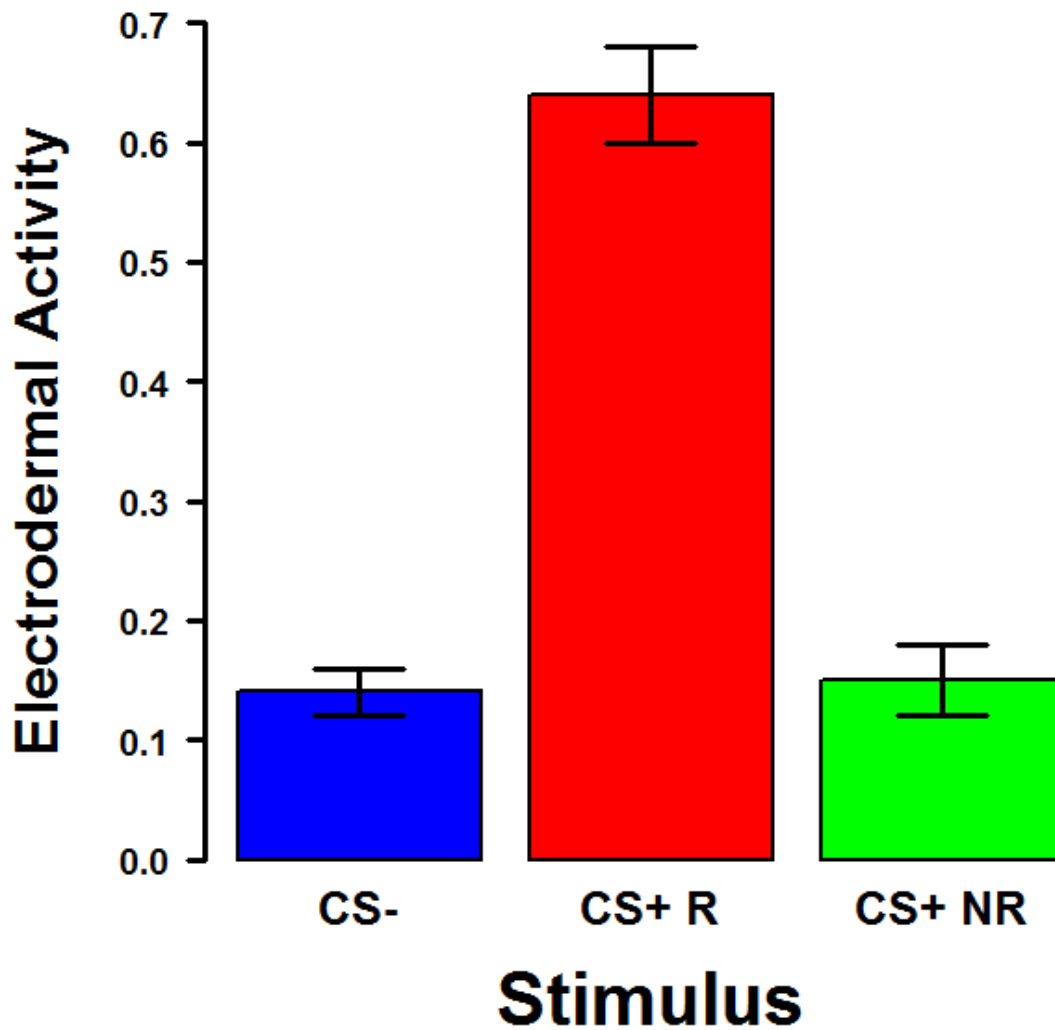


Figure 2. $N = 62$. Electrodermal activity (EDA) during the observation phase. CS+ R = reinforced CS+ presentations; CS+ NR = nonreinforced CS+ presentations. EDA values at left have been mathematically transformed (see EDA Data Analysis). Higher EDA reflects more physiological reactivity. Error bars represent ± 1 SEM.

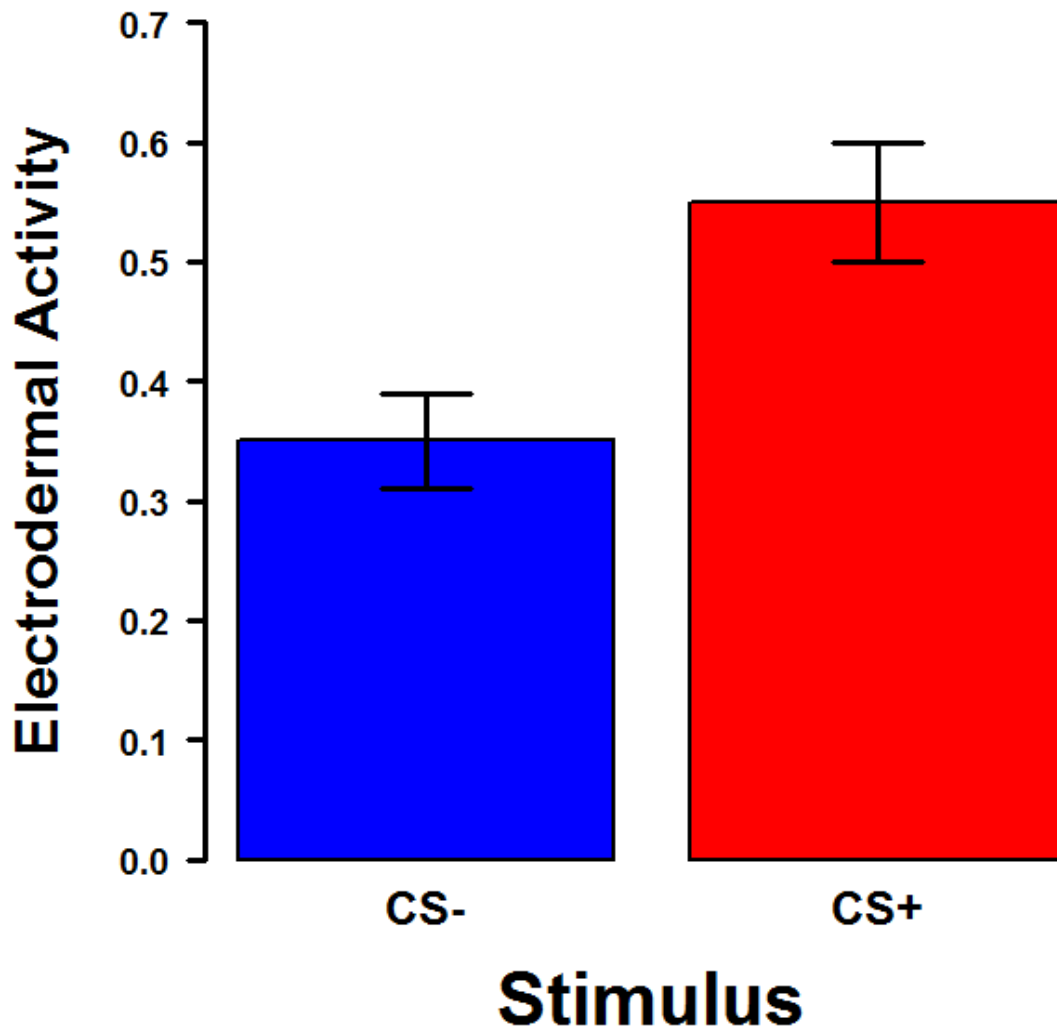


Figure 3. $N = 76$. Mean electrodermal activity (EDA) during the test phase. CS+ R = reinforced CS+ presentations; CS+ NR = nonreinforced CS+ presentations. EDA values at left have been mathematically transformed (see EDA Data Analysis). Higher EDA reflects more physiological reactivity. Error bars represent ± 1 SEM.

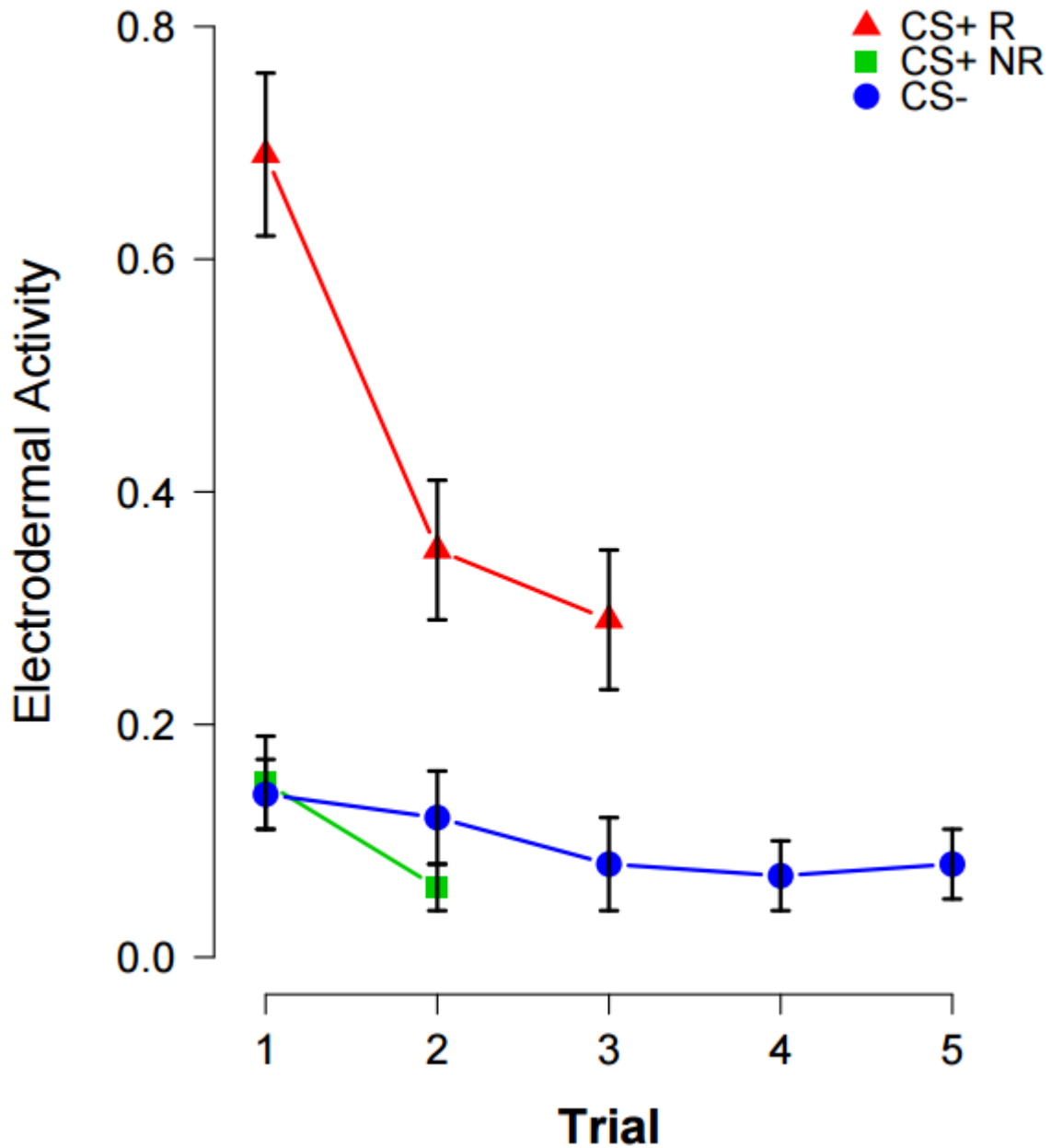


Figure 4. $N = 62$. Electrodermal activity (EDA) during the observation phase. CS+ R = reinforced CS+ presentations; CS+ NR = nonreinforced CS+ presentations. EDA values are measured in microsiemens (μS). Higher EDA reflects more physiological reactivity. Error bars represent ± 1 SEM.

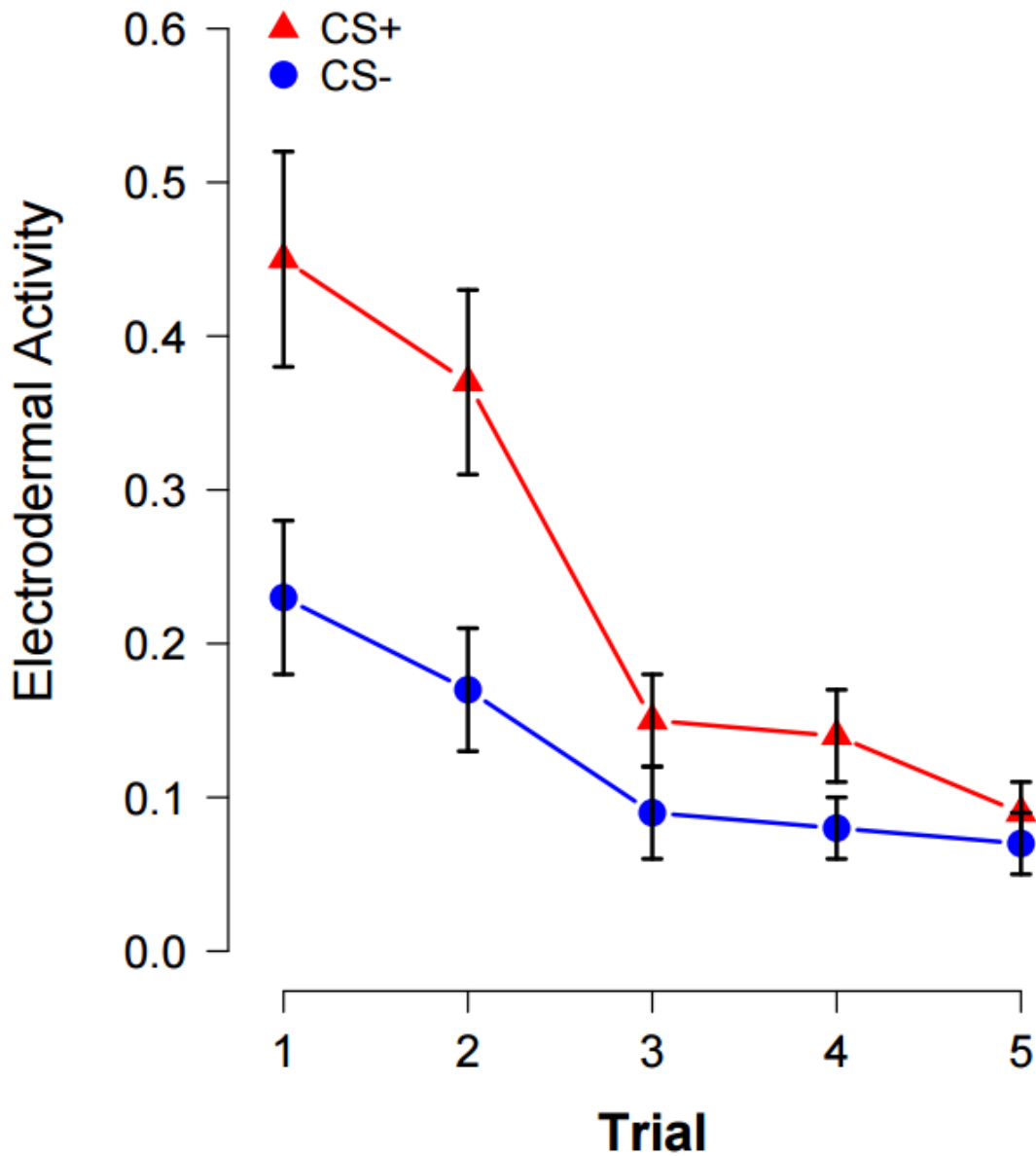


Figure 5. $N = 76$. Electrodermal activity (EDA) during the test phase. EDA is measured in microsiemens (μS). Higher EDA reflects more physiological reactivity. Error bars represent ± 1 SEM.

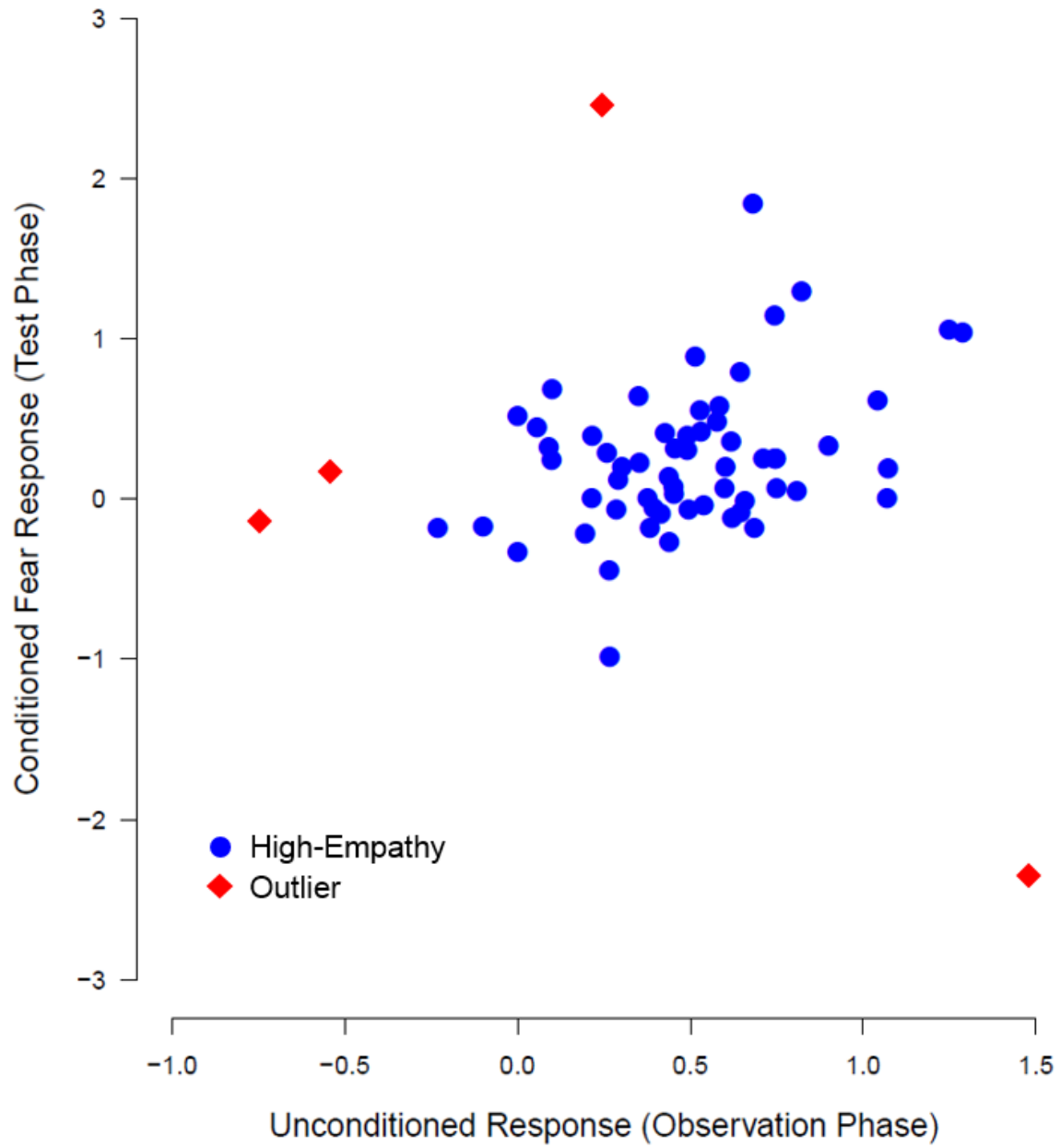


Figure 6. $N = 62$. The Unconditioned Response (UR) and Conditioned Fear Response (CFR). Outliers appear in red.