Discussion

The results of experiments 1 and 2 demonstrated that there was a decrease in skin conductance response, as demonstrated both through the CFS and VM techniques. In an examination of the acquisition and extinction phases, there was no difference between the three groups in terms of skin conductance response between the acquisition phase and the initial stage of the extinction phase. In contrast, skin conductance response decreased among the aware and unaware groups, but not the control group, between the end of the extinction phase and the post-test phase. In other words, despite the short duration of the presentation of the stimulus in the unaware group, participants’ skin conductance response was similar to the aware group, in which participants were exposed to the stimuli for a relatively long duration. Participants in the control group, who were not exposed to any stimuli, did not show any significant decrease in their skin conductance response.

The results of these two experiments demonstrate unconscious extinction under laboratory conditions. Previous studies have demonstrated that masked images helped to reduce fearful responses (Siegel & Weinberger, 2009; 2011; Siegel, 2017), but not when using CFS (Koizumi et al., 2016). To the best of our knowledge, the current study is the first study to compare acquisition and extinction across two techniques – VM and CFS – through a controlled laboratory experiment.

Over the years, various techniques have been developed to suppress awareness to stimuli and to measure the effects of unconscious stimuli, among other things, on learning processes. These studies have shown that different techniques sometimes produce different results (Fogelson et al., 2014; Dubois & Faivre, 2014). Therefore, it is important to examine the role of awareness using more than one technique. In the current study, we used a different technique in each experiment. In experiment 1, we used the CSF technique, a technique whose most notable advantage is the duration of stimuli presentation. In experiment 2, we used the VM technique, whose salient advantage is its sensitivity. Despite the different methods (Stein & Strezer, 2014) and the different unconscious processes that these techniques uncover (Fogelson et al., 2014), we find, across both experiments, using both techniques, that we are able to demonstrate unconscious extinction of stimuli. Is this finding surprising?

Studies have shown that CFS allows for awareness that can assist high-level processing (Gelbard-Sagiv, Faivre, Mudrik, & Koch, 2016). Other studies have shown that the use of the VM technique affects behavioral processes, even when the stimulus is outside of participants’ awareness (Whalen et al. 1998; Öhman & Soares 1994; Dimberg et al. 2000). There is also evidence that therapeutic processes occur during VM. Therefore, the results of the current study add to the existing evidence that demonstrate the ability to perform extinction under conditions of unconscious awareness. The simplicity of this methodology, which does not require equipment beyond a computer screen or a cellular phone, means that it can be easily used by therapists who conduct exposure therapy.

The results of this study may shed light on the level of awareness required to perform exposure therapy. One of the therapeutic strategies that support the inhibitory learning model is expectancy violation. Expectancy violation stems from the premise that the mismatch between expectation and reality is necessary for learning. In other words, this creates a \_\_\_\_ expectation that “competes” with the arousing expectation. Inhibitory learning occurs as expectations are **violated** in response to accumulated experiences (Craske, 2014; Blakey & Abramowitz, 2016). (In my own words, the idea here is not to stay in the fear experience, and to wait for the fear to slowly dissipate and diminish like in habituation, rather to aim, for example, to destroy the expectation of “the dog will bite me.” In this way, new learning can take place by way of the expectations being destroyed, such that the dog will not bite).

A key aspect of the Expectancy Violation model is the allocation of **attention** to the conditioned stimulus and the non-occurrence of the unconditioned stimulus. In light of the fact that extinction learning refers to the formation of non-coincidental associations between the conditioned and unconditioned stimulus, **awareness** of both the stimulus and the non-occurrence of the unconditioned stimulus is necessary (Craske, 2014). (In my own words: I have to pay attention and to be very aware to the existence of the stimuli in order to discern the association and proximity between them). The findings of the current study suggest that extinction can also occur outside of conscious awareness. Therefore, it is plausible that the process of exposure can occur with a lesser extent of attention than what the theory expects.

Various methods have been utilized to distinguish between conscious and unconscious processes in the context of fear. In these studies, researchers have attempted to examine how unconscious stimuli affect people both physiologically and behaviorally (Öhman, 1986, 1993; Dimberg & Öhman, 1996; Öhman et al., 2000a; Raio et al., 2012). According to higher-order theories of consciousness, we would expect that the perception of fear would be different and separate from its physiological basis, such that the former would reflect the latter. In other words, my fear would reflect my physiological expression. The results of the current study, along with previous studies (Siegel, 2017; Killgore, Britton, Schwab, Price, Weiner, Gold, & Rauch, 2014; Nuske, Vivanti, Hudry, & Dissanayake, 2014), have demonstrated that psychological interventions that influence unconscious defensive processes may, in turn, influence conscious symptoms. This conclusion has a number of practical implications that can be examined in future studies.

Skin conductance response (SCR) is a sensitive and convenient measure that can measure arousal in the sympathetic nervous system, as a function of emotional and cognitive changes. Usually SCR is measured alongside other variables such as heart rate, respiratory rate and blood pressure. These variables are part of the autonomic nervous system and are activated in the fight or flight mechanism (Critchley, 2002). The startle reflex is another component of the defense response to fear (Öhman, & Mineka, 2001). In future studies, it will be important to examine the ability to carry out unconscious extinction and to use additional measures to validate and generalize the findings of the present study.

Fear and anxiety are emotions that are typically associated with anxiety disorders. However, research has shown that anxiety orders such as phobia of spiders, contamination-related obsessive-compulsive disorder and phobia of blood and needles, are also associated with an additional emotion – disgust (Woody & Teachman, 2000). Fear and disgust share a commonality: both of them are characterized as “negative affect” and both of them are expressed through an avoidance of the stimulus, out of concern of injury (Stark et al., 2003). Additionally, fear and disgust both fit into the classic conditioning model (Woody & Teachman, 2000) and both of these emotions increase SCR (Beadley, Codispoti, Cuthbert, & Lang, 2010). The similarity between fear and disgust has practical significance for unconscious extinction of stimuli that arouse disgust, such as in exposure therapy for obsessive-compulsive disorder (Abramowitz & Foa, 2000).

In the current experiment, we hypothesized that there would be no significant difference between the conscious exposure group and the non-conscious exposure group, as compared to the non-exposure group. What is the significance of these findings in a clinical context? In clinical treatment, exposure may vary in duration. Studies show that in-session habituation can be successful as the exposure duration increases (Bouchard et al., 2004). In addition, prolonged exposure has been found to be more effective at reducing fear than short exposure sessions (e.g., Antony & Swinsom, 2000; Meadow & Philpps, 2007). Can these findings be applied to conscious exposure as well as unconscious exposure? Future studies should explore whether increasing the duration of unconscious extinction affects physiological reactions.

Page and colleagues (1999; 2003) have found evidence to support that, for at least some forms, distraction may reduce the intensity of fear during exposure. Additionally, safety behaviors (Milosevic & Radomsky, 2008) were found to not interfere with treatment and to potentially aid in treatment under certain circumstances. Research has shown that distraction strategies can cause one to feel that events and emotions are under one’s control, such that people feel a sense of security and control in their ability to handle a situation and to carry out a particular task. Therefore, distraction may improve the effectiveness of exposure as a result of increased sense of control and self-efficacy (Craske, Street, & Barlow, 1989; Page et al., 2008).

If the process of unconscious extinction is indeed similar to the process of conscious extinction, might a person who undergoes unconscious exposure, similar to distraction, function better, feel more capable in him/herself, and thus experience an increase in treatment efficacy? Future research should explore these aspects, with the idea that perhaps in the future, early treatment of unconscious exposure could complement existing forms of exposure therapy.