**Is conscious awareness needed for fear extinction?**

**INTRODUCTION**

**Fear conditioning and anxiety disorders**

Classical fear conditioning concerns the learning of an association between a neutral and an aversive stimulus. Through their repeated pairing, the neutral stimulus becomes an indicator for the negative effect (Lovibond & Shanks, 2002). Acquisition refers to the process in which the neutral conditioned stimulus (CS) becomes associated with the aversive unconditioned stimulus (UCS). In contrast, extinction is characterized by the opposite process, in which the conditioned stimulus is presented repeatedly *without* the aversive stimulus, thereby weakening the association between the two.

Fear conditioning may be regarded as an adaptive form of learning, which contributes to survival (Ohman & Mineka, 2001). Nonetheless, occasionally, it may be a source for the development of psychological disorders; for example, in cases in which anxious reactivity to a conditioned stimulus continues to exist, even in the absence of an association between the conditioned stimulus and the aversive unconditioned stimulus (Lissek, 2005). Several theories have postulated that fear conditioning underlies various anxiety disorders, post-traumatic stress disorder and other psychopathologies (Mineka, 2008). Anxiety disorders are the most prevalent psychiatric disorders (Kessler, Chiu, Demler, & Walters, 2005), and the most effective treatment for anxiety disorders is exposure (Deacon & Abramowitz, 2004). The goal of exposure is to facilitate extinction – that is, to reduce the conditioned fear response to the feared stimuli (Abramowitz, 2013). Although effective psychological and pharmacological treatments exist for anxiety disorders (Alonso, 2004), most people with anxiety disorders never seek treatment (Wittchen et. al., 2010). A possible explanation for these low rates of treatment-seeking is that patients consider confronting feared objects or situations as overly demanding. The lack of treatment-seeking highlights the need for novel interventions.

The inhibitory learning model is a common model used for understanding extinction, yet other mechanisms for reducing fear have also been suggested, such as habituation (i.e., a decrease in the strength of reaction to a certain stimulus following repeated exposure to it). In the process of extinction, the association between the conditioned stimulus and the aversive stimulus is not erased, rather a new association is made, such that the conditioned stimulus is not presented with the aversive stimulus.

**Fear conditioning without conscious awareness**

In recent years, there has been increasing evidence suggesting that fearful responses can occur even without explicit stimulus presentation (Ohman, 1986, 1993; Dimberg & Ohman, 1996; Ohman et. al., 2000a, Raio et. al., 2012). One study examined whether fearful expressions emerge from suppression into awareness more quickly relative to images of neutral or happy expressions. Fearful faces were found to emerge faster, suggesting that emotional expressions are unconsciously processed (Yang, Zald, & Blake, 2007). These results are supported by findings that show increased amygdala activation in response to fearful faces compared with happy, masked faces (Whallen, 1998). Findings are further in line with LeDoux’s (1996) suggestion that a direct path exists between the thalamus and the amygdala, such that information may evoke fear, even without activation of the visual cortex.

If learning can occur without an explicit presentation of a stimulus, and fear can be acquired and experimentally evoked outside of awareness, it is plausible that fear could diminish under similar conditions. Although learning without explicit stimulus presentation has been previously demonstrated, the question of whether fear can be reduced without explicit exposure remains largely unknown. There are, however, several studies that have tested whether subliminal exposure to images of spiders affects one’s willingness to approach a spider among people who are afraid of spiders (Siegel & Weinberger, 2009; 2011). In these studies, participants completed a behavioral avoidance test (BAT) one week after a masked exposure to a spider to examine long-term effects of this form of exposure. They were then presented with images of spiders, either masked or unmasked. Participants in the masked condition were more willing to approach a spider than those who were consciously exposed to pictures of spiders. These findings were replicated with two-week and one-year follow-up measurements (Siegel & Warren, 2013; Siegel & Weinberger, 2012).

Other relevant outcomes are those that concern physiological responses. One recent study measured participants’ skin conductance in response to exposure and concluded that masked extinction is not associated with increased physiological responses in the extinction process (Siegel, 2017). It is important to note that, except for one recent study in which skin conductance was measured, extinction studies have largely been based on behavioral measurements. In this recent study, participants in the masked condition succeeded more in the BAT. However, no evidence for reduced physiological responses was obtained (Siegel, 2017). Furthermore, another methodological limitation in the aforementioned study concerns the way in which awareness was measured. Participants were asked, in a preliminary masking experiment, to identify the masked images. However, these participants did not participate in the main experiment and, therefore, it is impossible to ascertain whether participants were aware of the spider images. In order to verify whether participants are aware of stimuli presented during exposure, trial-by-trial awareness should be assessed and objective, as well as subjective, measures need to be employed.

**Methodologies for the presentation of unconscious stimuli**

Various techniques have been developed to suppress stimuli from awareness and assess unconscious processing. These techniques measure the impact of specific stimuli on participants’ thoughts, feelings, actions and learning processes (Kouider & Dehaene, 2007; Stein & Sterzer, 2014). We focus on two prominent techniques: visual masking (VM; Breitmeyer & Ogmen, 2000, 2006; Kahneman, 1968) and continuous flash suppression (CFS; Tsuchyia & Koch, 2005). In VM, a stimulus (“target”) is presented for a short duration of several dozens of milliseconds or less, and is immediately preceded/followed by masks, which causes it to be suppressed from awareness (Breitmeyer & Ogmen, 2000, 2006; Kahneman, 1968). CFS relies on dichoptic vision to render stimuli invisible. In other words, a target stimulus is presented to one eye, while the other eye is consistently exposed to a changing pattern of different shapes. This technique prevents participants from seeing the constant target image for a relatively long period of time (up to several seconds) (Tsuchyia & Koch, 2005). Importantly, the two techniques may involve different underlying mechanisms and may evoke different types of unconscious processing (Breitmeyer, 2004; Kim & Blake, 2006; Fogelson et. al., 2014); therefore, employing both unconscious methodologies is imperative when studying unconscious processes.

Typically, a combination of subjective and objective measures is used to ascertain that stimuli were indeed invisible. In the former, participants report the content of their perception, either dichotomously (i.e., “I saw/didn’t see the stimulus”) or – more commonly – on a gradual scale (e.g., using a perceptual awareness scale; Ramsey & Overgaard, 2004). Objective measures focus on participants’ performance regarding the suppressed stimuli. These objective measures operate under the assumption that, if the stimuli were indeed invisible, participants’ explicit judgment of them should be at chance level (Reingold & Merikle, 1998; for a discussion on the limitations of both subjective and objective measures, see Snodgrass et. al., 2004).

Two commonly used autonomic measures of fear conditioning are skin conductance (Esteves, Critchley, Mathias, Parra, Dimberg, & Öhman, 1994) and heart rate (Öhman & Mineka, 2001(. Studies have demonstrated that these measures contribute to the understanding of anxiety disorders when used in experiments of fear conditioning (Bunce, Bernat, Wong, & Shevrin, 1999). The present research aims to evaluate the feasibility and robustness of extinction evoked by unconsciously perceived stimuli by using two common methodologies, CFS and VM. We include both measures because CFS has the advantage of utilizing a long duration of stimuli presentation, whereas some have claimed that VM allows for higher-level processing than CFS (Stein & Strezer, 2014).

**EXPERIMENT 1**

**Method**

*Participants*. Forty-eight undergraduate participants received course credit for partaking in a two-hour laboratory session. All participants provided written informed consent prior to completion of the experiment.

*Stimuli and Apparatus*

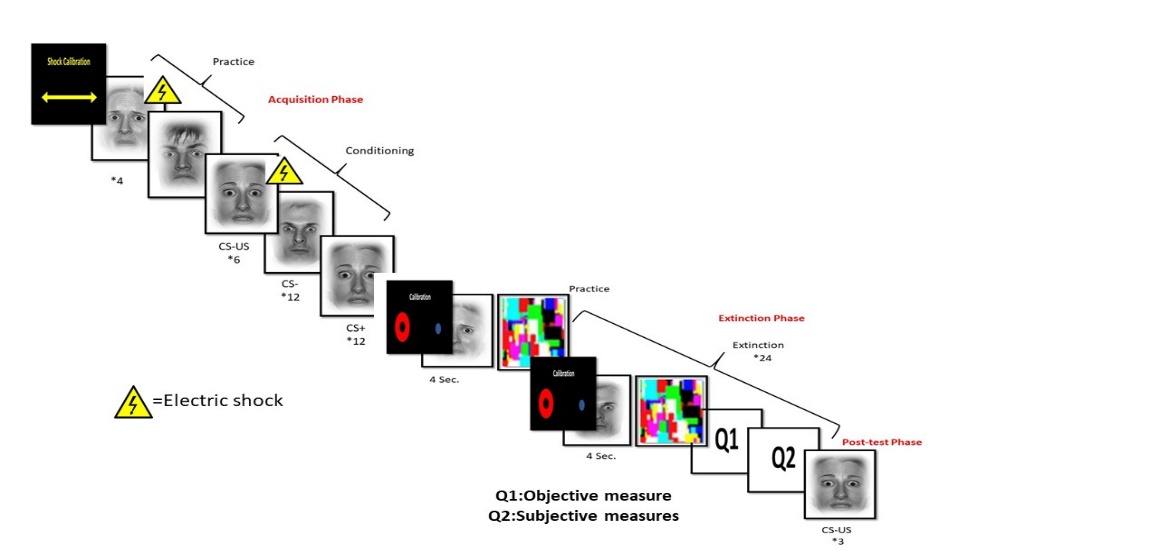
Participants viewed a pre-installed computer presentation on a monitor while changes in their skin conductance were measured. In the presentation, participants were presented with a conditioned stimuli (CS+ and CS-): either a scared face of a man or a woman. While the conditioned stimulus was presented, participants received mild electric shocks at a level that they determined to be “aversive” (undesired and unpleasant) and “uncomfortable, but not painful” (Öhman, Erixon, & Löfberg, 1975). In addition, participants completed self-report measures. Further details are provided in the [Supplemental Experimental Procedures.](#_Supplemental_Experimental_Procedure_1)

*Procedure*

All participants underwent three phases during the experiment: acquisition, extinction, and testing (see Figure 1). The experiment started with an acquisition phase, during which participants were presented with a face of a woman or a man, while receiving an electric shock during some of the trials (4 practice trials, 12 CS+ trials, 12 CS- trials, 6 CS-US trials). The order of stimuli appearance was pseudo-randomized. Subsequently, participants underwent an extinction phase, in which they were presented with the same stimuli again, but **without the accompanying electric shock** (12 CS+ trials, 12 CS- trials). Participants were then divided into three groups: (1) “Unaware Group” – a subliminal stimulus (face of a man or a woman) was presented for four seconds in the extinction phase by using CSF, (2) “Aware Group” –a face of a man or a woman was presented for four seconds, and (3) “Control Group” – a scrambled face stimulus was presented for four seconds using CSF. The control group served as a comparison, non-extinction group. Participants in the control group were exposed to the same technical procedures as the group receiving unconscious CSF extinction.

Participants in the unaware group and the control group, in which CFS was used, were asked two questions at the end of each trial. These questions were used as objective and subjective measures in order to confirm the level of the participants’ awareness. The objective question was: Was the picture presented of a man or a woman? The subjective question was: How sure are you that you saw the picture? (1 = “I did not see anything” to 4 = “I saw the picture clearly”).

Finally, all participants underwent a testing phase to assess the effects of conscious and unconscious extinction relative to the control group, who received no extinction process. In the testing phase, all three groups were presented with the same stimuli that were used in the acquisition of fear phase. The stimuli were paired with the receipt of an electric shock in one of the trials, in order to measure the recovery process in all three groups. Following the testing phase, the experimenter asked participants to complete debriefing questionnaires and to report what they believed to be the purpose of the study.



**Figure 1.** Experimental procedure and stimuli.

**Results and discussion**

Objective and subjective measures. First, participants’ responses from the extinction phase among the unaware group were analyzed to test for awareness. The subjective ratings showed that 80.2% of the trials were rated as 1 (“I did not see anything”) and 14.6% as 2 (“I had a vague perception of something”). Only 0.4% were rated as either 3 (“I saw a clear part of the image”) or 4 ("I saw the picture clearly"). Responses to the objective measure -- participants’ accuracy of whether the picture was of man or woman -- was 48%, which was not different than chance [(t(40) = 3.42, p=0.56].

Skin conductance. Normalized skin conductance response (SCR) differences were entered in a two-way mixed model ANOVA with a between-subjects factor of group (aware, unaware, no extinction) and a within-subjects factor of extinction time (early extinction, late extinction and post-test). There was a main effect of extinction time [F (2, 76) = 13.20, p < 0.001], an effect of group [F (2,38) = 9.170, p = 0.01], and a significant interaction between group and extinction time [F(2,38) = 10.582, p < 0.001; see Figure 2]. Simple effects analyses showed that there was a difference between the three groups (aware, unaware, control) in the post-test stage (p < 0.001) and in the late extinction stage (p=0.044), but not in the early extinction stage (p=.77). In addition, in order to delineate the temporal sequence of change, normalized SCR differences were entered into a two-way mixed model ANOVA with a between-subjects factor of group (aware, unaware, control) and a within-subjects factor of the latter half of acquisition phase trials compared to the post-test phase (late acquisition vs. post-test). There was a main effect of time [F (1, 38) = 25.47, p < 0.001], a main effect of group [F(1,38) = 6.79, p = 0.03], and a significant interaction between group and time [F(2,38) = 10.968, p < 0.001]. The pairwise comparison for the main effect of group showed a difference between SCR in the control group and the aware group (p=0.002) and between the control group and the unaware group (p=0.04), but not between the unaware group and aware group (p=0.09; see Figure 2).

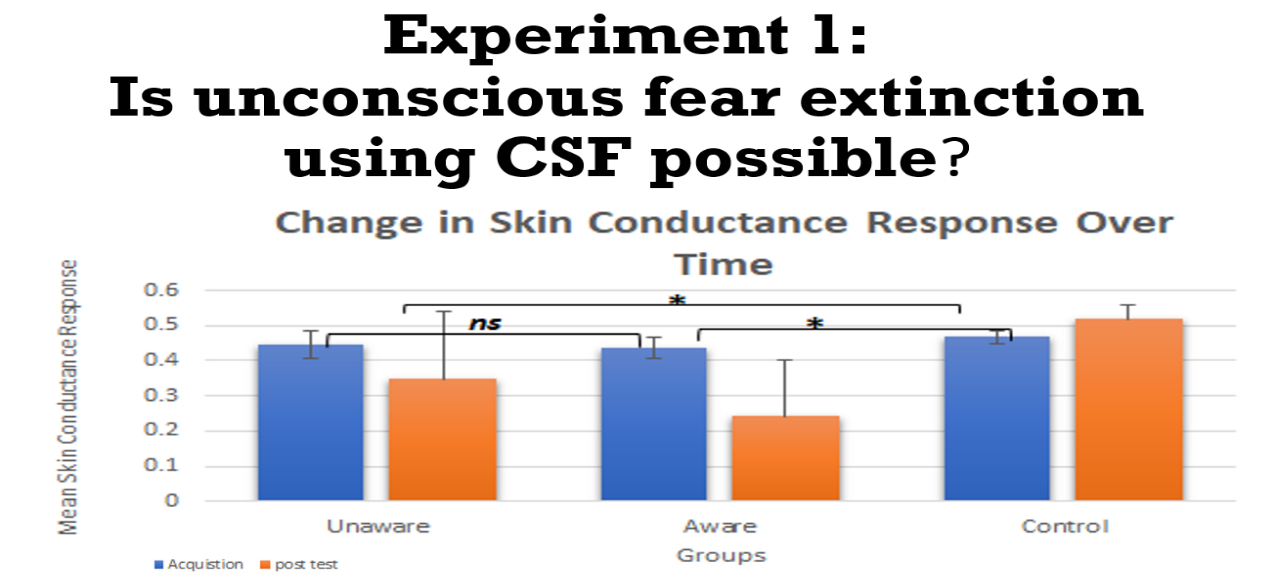


Figure 2. Normalized SCR differences across the unaware, aware, and control groups.

Taken together, the results suggest a decrease in skin conductance both in the conscious and unconscious groups, to a comparable degree. At the phase of acquisition, as well as the initial phase of extinction, there was no distinctive difference between the groups. However, in the final extinction phase and in the post-test phase, participants’ levels of skin conductance decreased in both the conscious and unconscious group, but not in the control group (see Figure 1). These findings confirmed the results of Weinberger & Siegel (2009, 2011, 2012) and demonstrated that effects persist even when awareness is properly controlled and measured.

**EXPERIMENT 2**

The findings of experiment 1 suggest that it is possible to unconsciously extinct a fearful conditioned stimulus with CFS. Experiment 2 examined extinction with VM to determine if the techniques differ in their efficacy in inducing unconscious extinction. Indeed, there is some indirect evidence suggesting differential processes in CFS and VM. For example, several studies employing VM demonstrated that awareness is not necessary for the processing of facial expressions (Whalen et. al., 1998, 2004; Murphy & Zajonc, 1993). However, studies using CFS have indicated that participants experience difficulty processing facial expressions unconsciously (Amihai, 2010; Moradi, 2005; Shin et. al., 2009).

In the current experiment, participants first underwent a fear acquisition phase in which a neutral stimulus – an image of a man or a woman – was presented with an accompanying electrical shock. In the second phase, they were presented with the same stimulus again, but this time the stimulus was presented without the electrical shock. Finally, all participants underwent a testing phase to assess the effects of conscious and unconscious extinction relative to the control group, who received no extinction process.

**Method**

The methods of experiment 2 were identical to those described in experiment 1, with the exception of the following:

*Participants*

GPower software version 3.0.5 (Faul et al. 2007) was used to determine the required sample size to obtain an effect size (ES) estimate of 0.25, which was chosen based on the results of the first experiment. The projected sample size needed for an ES of 0.25 with an alpha of 0.05, power (1–β) of 0.95, three groups, and three repetitions was 60. As such, we decided to recruit 72 participants for the current study.

*Stimuli and Procedure*

Participants were randomly assigned to one of three extinction groups: (1) “Unaware Group” -- a subliminal stimulus (face of a man or a woman, as detailed in experiment 1) was presented by VM, (2) “Aware Group”-- a face of a man or a woman was presented for a duration of four seconds, and (3) “Control Group” -- a scrambled face stimuli was presented by VM. The control group did not undergo extinction.

The masking stimulus was

The extinction phase included 24 trials: 12 trials with a CS+ and 12 trials with a CS-. All of the man/woman pictures used in the acquisition phase were masked by using scrambled face stimuli. The target stimulus was presented for 33 milliseconds and the masked stimuli were presented for an additional 6 seconds. The stimuli were presented in a counterbalanced order.

As in experiment 1, after the presentation of each target–mask pair, participants indicated whether they saw a man or woman by pressing a button. Then, participants rated their confidence in their response on a scale of 1 to 4 (1= “I did not see anything” to 4 = “I saw the picture clearly”).

Participants in the unaware group and the control group, in which VM was used, were asked two questions at the end of each trial. These questions were used as objective and subjective measures in order to confirm the level of the participants’ awareness. The objective question was: Was the picture presented of a man or a woman? The subjective question was: How well did you see the picture? (1 = “I did not see anything” to 4 = “I saw the picture clearly”).

**RESULTS**

Out of the 83 participants, 11 participants were excluded. Three participants

were excluded due to technical problems with data recording. As previously mentioned, the minimal SCR criterion was 0.02ms. Responses lower than this pre-determined criterion were recorded as zero. Eight participants were classified as non-responders because they lacked a measurable SCR on >75% of the trials and, thus, were excluded from analyses.

**Objective and Subjective Measures**

As in experiment 1, awareness was assessed according to subjective and objective criteria. The subjective ratings showed that 83.9% of the trials were rated as 1 (“I did not see anything”), and 13.1% as 2 (“I had a vague perception of something”). Only 2.89% were rated as either 3 (“I saw a clear part of the image”) or 4 ("I saw the picture clearly"). In regards to the objective measure, participants across all trials were not able to detect whether the picture was of a man or woman at a level greater than chance [M = 47%, SD = 1.38%, t(23) = -1.04, p =0.152]. This null result was confirmed by a Bayesian paired-sample t-test which revealed that, given our data, the null hypothesis was 2.86 times more likely than the alternate hypothesis.

**Skin Conductance Responses**

**Acquisition Phase**

Skin conductance responses to the CS+ were larger than those to the CS- [F (1,69) =139.92, p < 0.001]. This difference was equally pronounced across all groups (F < 1, ns).

Table 1

*Mean Skin Conductance Response to the conditioned stimulus (CS+) and unconditioned stimulus (CS−)*

|  |  |  |  |
| --- | --- | --- | --- |
|  | CS- |  | CS+ |
| Conditions | M (SD) |  | M (SD) |
| Unaware | 0.45 (0.09) |  | 0.61 (0.10) |
| Aware | 0.45 (0.09) |  | 0.64 (0.15) |
| Control | 0.45 (0.11) |  | 0.70 (0.11) |
| Total | 0.45 (0.10) |  | 0.65 (0.12) |

**Extinction Phase**

To test the effects of within-subjects and between-subjects variables on electrodermal responses, a mixed-model analysis of variance was conducted with a between-subjects factor of condition (aware, unaware, and control) and within-subjects factor of extinction time (early extinction, late extinction and post-test). Analyses were performed separately for early (first half of trials) and late (second half of trials) extinction.

Main effects of time [F (1, 69) =83.954, p < 0.001, partial *η*2 = 0.35] and condition [F (2, 69) = 7.998, p < 0.001, partial *η*2 = 0.33], as well as the interaction of condition and time, were found [F (2, 69) = 43.541, p < 0.00, partial *η*2 = 0.3]. The post-hoc pairwise comparison for the main effect of time showed a difference between skin conductance responses for participants in the control group and participants in the aware group (p < 0.001), as well as between those in the control group and the unaware group (p < 0.001). No differences in SCR were found for the unaware group and aware groups in the post-test phase (p=0.06; additional analyses appear in Table 2).

Table 2

*Significance levels of post-hoc comparisons*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Unaware | Aware | Control |
| Time | Conditions |  |  |  |
| Early Extinction | Unaware |  | p=0.254 | p=0.344 |
| Aware | p=0.254 |  | p<0.001 |
| Control | p=0.344 | p<0.001 |  |
| Late Extinction | Unaware |  | p=0.014 | p=0.119 |
| Aware | p=0.014 |  | p<0.001 |
| Control | p=0.119 | p<0.001 |  |
| Post-test | Unaware |  | p=0.06 | p<0.001 |
| Aware | p=0.06 |  | p<0.001 |
| Control | p<0.001 | p<0.001 |  |

**Skin conductance over time**

Figure 2 presents the changing pattern of skin conductance over time. Whereas, in the acquisition phase, the skin conductance responses in the three groups were similar, the differences between the groups in the extinction phase were more noticeable, and differed by the level of awareness. The GLMM analysis revealed a significant effect of time (p < 0.0001), as well as a significant interaction effect (p < 0.0001).

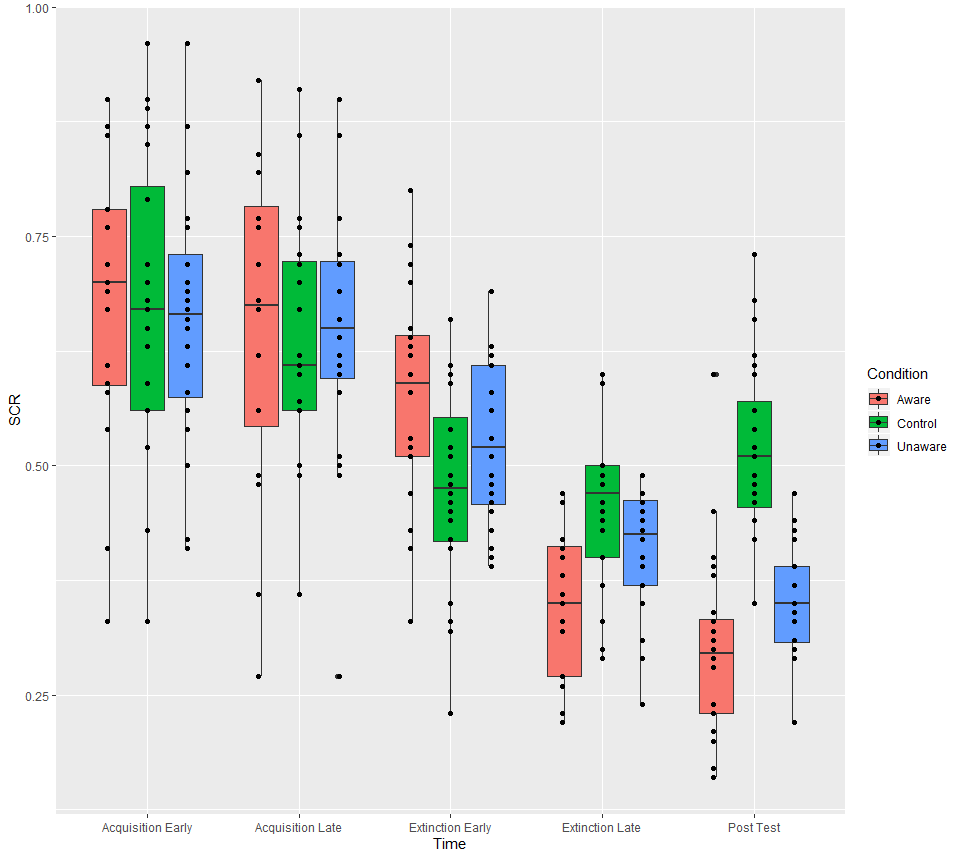


Figure 1. Skin conductance over time

The pairwise comparison analysis demonstrated that, for the unaware group, responses declined between early and late extinction (p<0.0001) and post-test (p<0.0001); however, responses did not differ throughout the acquisition phase (p=1.00). Similarly, in the aware group, responses declined between early and late extinction (p<0.0001) and post-test (p<0.0001), but responses did not differ throughout the acquisition phase (p=1.00). For the control group, the responses in the acquisition phase did not differ (p=0.176). As opposed to the unaware and aware groups, the responses in the control group did not differ between early and late extinction (p=1.00) and post-test (p=0.635).

דיון

מתוצאות ניסוי 1 ו-2 ניכר כי ישנה ירידה במדד המוליכות העורית גם בטכניקה של CFS וגם בטכניקה של VM. בבואנו לבחון את תהליך הרכישה וההכחדה, נראה כי בשלב הרכישה ובשלב הראשוני של ההכחדה, אין הבדל בין שלושת הקבוצות במדד המוליכות העורית. לעומת זאת בסוף שלב ההכחדה ובשלב ה-POST TEST המוליכות העורית יורדת בקבוצות החשיפה המודעת ובקבוצת החשיפה הלא-מודעת, אך לא בקבוצת הביקורת. כלומר, למרות זמן ההצגה הקצר בקבוצת החשיפה הלא מודעת, המוליכות העורית של הנבדקים היתה דומה לקבוצת החשיפה, בה הוצגו לנבדקים הגירויים למשך זמן ארוך. בקבוצת הביקורת שלא עברה כלל חשיפה לגירויים, לא נרשמה ירידה משמעותית במדד המוליכות העורית.

תוצאות שני הניסויים הללו מדגימות הכחדה לא מודעת בתנאי מעבדה. מחקרים הדגימו כיצד תמונות ממוסכות (masked) מסייעות בהפחתת פחד (Siegel & Weinberger, 2009; 2011; Siegel,2017), אך לא בטכניקה של CFS (Koizumi et al., 2016). מחקר זה ככל הנראה הינו המחקר הראשון בו מתבצעת רכישה והכחדה באופן מבוקר בתנאי מעבדה, ,תוך השוואה בין שתי טכניקות: VM ו- .CFS

במרוצת השנים טכניקות שונות פותחו על מנת לדכא גירויים מהמודעות, ולאמוד את השפעתם של גירויים לא מודעים אלה בין היתר, על תהליכי למידה. ממחקרים עולה כי טכניקות שונות עשויות להניב לעיתים תוצאות שונות (Fogelson et al., 2014; Dubois & Faivre, 2014). מכאן עולה החשיבות לבחון באמצעות יותר מטכניקה אחת את תפקידה של המודעות. במחקר הנוכחי השתמשנו בכל ניסוי בטכניקה שונה. בניסוי מספר 1 השתמשנו ב-CSF שהיתרון הבולט שבה הוא משך הצגת הגירוי. בניסוי מספר 2 השתמשנו בטכניקה של VM שהיתרון הבולט הוא רגישותו. על-אף ההבדל בין השיטות (Stein & Strezer,2014) ובתהליכים הלא מודעים שטכניקות אלה חושפות (Fogelson et al., 2014), קיבלנו שבשתיהן ניתן להכחיד גירוי באופן לא מודע. האם הממצא הזה אמור להפתיע? מחקרים מראים ש-

CFS allows for awareness that can assist high-level processing

(Gelbard-Sagiv, Faivre, Mudrik, & Koch, 2016)

מחקרים מראים שהשימוש בטכניקה של VM משפיעה על תהליכים התנהגותיים גם כשהגירוי נמצא מחוץ למודעות הנבדקים (Whalen et al. 1998, Ohman & Soares 1994, Dimberg et al. 2000). קיימות גם עדויות לתהליכים תרפויטים המתקיימים באמצעות (Siegel, 2018) VM. מכאן, שתוצאות המחקר הנוכחי הן עדות נוספת ליכולת לבצע הכחדה בלתי מודעת. פשטותה של מתודולוגיה זו שאינה מצריכה מכשור פרט למסך מחשב או טלפון נייד, יכולה לשמש ככלי עתידי עבור מטפלים בביצוע חשיפה.

תוצאות המחקר עשויות לשפוך אור על מידת הקשב הנחוצה בביצוע חשיפה בטיפול. אחת מהאסטרטגיות הטיפוליות התומכות את מודל הלמידה האינהיביטורי היא Expectancy Violation. האסטרטגיה הזו נובעת מהנחת היסוד שחוסר הלימה בין הציפיה לבין מה שקורה בפועל, נחוצה עבור למידה חדשה. כלומר ככה נוצרת ציפייה מעכבת ש"מתחרה" עם הציפיה המעוררת. ככל שהציפייה **מופרת** על ידי הניסיון, ככה גדלה הלמידה המעכבת ( Craske, 2014;Blakey & Abramowitz,2016) (במילים שלי, הרעיון כאן הוא לא להיות בתוך חווית הפחד, ולחכות שהפחד אט-אט יתפוגג ויופחת כמו בהביטואציה, אלא לכוון לכך שהציפייה לדוגמא ש"הכלב ינשוך אותי" פשוט תופר. באופן הזה נוצרת למידה חדשה מהציפייה שהופרה, שכלב אינו נושך).

אספקט מרכזי במודל הפרת הציפיות (Expectancy Violation) היא הקצאת **קשב** לגירוי המותנה ולאי-התרחשותו של הגירוי הבלתי מותנה. לאור העובדה שלמידת הכחדה, מייצגת את היווצרות הקשר שאינו מקרי בין גירוי מותנה לגירוי בלתי מותנה, **מודעות** גם לגירוי וגם לאי התרחשותו של הגירוי הבלתי-מותנה, הינה נחוצה (Craske, 2014.‏) (במילים שלי: אני חייבת לשים לב ולהיות מאוד מודעות לקיומם של הגירויים, כדי להבחין בקשר ובסמיכות בהם שני אלה מתקיימים). מממצאי המחקר הנוכחי עולה כי ניתן לבצע הכחדה גם מחוץ למודעות, מכאן ויתכן ותהליך החשיפה יכול להתרחש עם מידה פחותה של קשב, ממה שהתיאוריה מצפה.

שיטות שונות ננקטו על מנת להבחין בין תהליכים מודעים לתהליכים לא מודעים בהקשר של פחד. במחקרים אלה ניסו לבחון באיזה אופן גירוי לא מודע משפיע פיזיולוגית והתנהגותית (Ohman, 1986, 1993; Dimberg & Ohman, 1996; Ohman et al., 2000a, Raio et al, 2012) לפי תיאוריות מסדר גבוה למודעות, אנו מצפים שתפיסת הפחד תיהיה שונה ונפרדת מהבסיס הפיזיולוגי, אך כן שהראשון ישקף את האחרון. כלומר שהפחד שלי ישקף את הביטוי הפיזיולוגי. תוצאות המחקר הנוכחי יחד עם מחקרים נוספים ((Siegel, 2017; Killgore, Britton, Schwab, Price, Weiner, Gold & Rauch, 2014; Nuske, Vivanti, Hudry & Dissanayake, 2014). ‏) מדגימות כי התערבות פסיכולוגית המשפיעה על תגובות הגנתיות שאינן מודעות, עשויה להשפיע בתורה על סימפטומים מודעים. למסקנה זו מספר השלכות יישומיות בהן ניתן להתמקד במחקרי המשך.

SCR (skin conductance response) הינו מדד רגיש ונוח (convenient) המסוגל לאמוד עוררות במערכת הסימפטית כתוצאה משינוי רגשי וקוגניטיבי. על-פי -רוב SCR נמדד יחד עם משתנים נוספים כגון: heart rate, respiratory rate, blood pressure. משתנים אלה שייכים למערכת העצבים האוטונומית ועשויים לבוא לידי ביטוי במנגנון Fight or Flight (Critchley , 2002). כמו-כן Startle Reflex הינו רכיב נוסף השייך לתגובות הגנתיות של פחד (Öhman, & Mineka, 2001‏). במחקר המשך ניתן לבחון את היכולת לבצע הכחדה לא מודעת ולהשתמש במדדים נוספים אלה על מנת לתקף והכליל את ממצאי המחקר הנוכחי.

פחד וחרדה הינם רגשות הנקשרים על פי רוב להפרעות חרדה. עם זאת, מחקרים מראים כי הפרעות חרדה כגון: פוביה מעכבישים, הפרעה אובססיבית קומפולסיבית הקשורה לזיהום, ופוביה ממחטים ודם, נקשרות גם עם רגש נוסף, גועל (Woody & Teachman, 2000) . לפחד וגועל מכנה משותף: שניהם מוגדרים "כרגש שלילי" (negative affect) ושניהם מלויים בהימנעות ובריחה מהגירוי, מחשש לפגיעה (Stark et al, 2003). בנוסף, פחד וגועל שניהם מתאימים למודל ההתניה הקלאסית (Woody & Teachman, 2000), ולנוכח שני הרגשות הללו מתעוררת עליה במוליכות העורית (Beadley, Codispoti, Cuthbert & Lang, 2010). לדמיון בין פחד וגועל קיימת השלכה יישומית-הכחדה לא מודעת לגירויים המעוררים גועל, כמו בטיפול בחשיפה בהפרעה אובססיבית קומפולסיבית (Abramowitz & Foa, 2000).

בניסוי הנוכחי קיבלנו שלא היה הבדל מובהק בין הקבוצה שעברה חשיפה מודעת לקבוצה שעברה חשיפה לא מודעת, בשונה מהקבוצה שלא עברה חשיפה כלל. מה משמעות ממצאים אלה בהיבט הקליני? בטיפול הקליני חשיפה עשויה להשתנות במשך שלה. מחקרים מראים כי in-session habituation עשויה להצליח ככל שמשך החשיפה גדול יותר (Bouchard et al., 2004).. בנוסף לכך, נמצא ש- Prolonged exposure יעילה יותר בהפחתת פחד יותר מאשר shorter exposure sessions (e.g., Antony & Swinsom, 2000; Meadow & Philpps, 2007) האם ניתן להקיש ממצאים אלה על חשיפה מודעת גם על חשיפה שאינה מודעת? במחקר המשך ניתן לבחון whether increasing the dosage of unconscious extinction affects physiological reaction.

Page et al (1999; 2003) מצאו עדויות שלפחות צורות מסוימות של הסחת דעת עשויות להפחית את עוצמות הפחד בחשיפה, והתנהגויות בטחון (Milosevic & Radomsky,2008 ) לא פוגמות בתהליך הטיפולי ואף עשויות לסייע לטיפול תחת נסיבות מסוימות. מחקרים מראים שאסטרטגיות הסחה גורמות לתחושה שאירועים ורגשות מתנהלים תחת שליטה. בדרך זו אנשים חשים עצמם בטוחים ותחת שליטה לגבי היכולת להתמודד עם סיטואציה ולבצע משימה ספציפית. הסחה לפיכך עשויה לשפר את יעילות החשיפה כתוצאה מתחושת השליטה ומסוגלות עצמית (self-efficacy) Craske, Street, & Barlow, 1989;Page et al, 2008))

אם אכן תהליך ההכחדה הלא מודע דומה לתהליך ההכחדה המודע, האם כאשר אדם מבצע חשיפה לא מודעת, בדומה להסחה, הוא עשוי לתפקד טוב יותר, לחוש עצמו בעל מסוגלות עצמית ולפיכך תעלה יעילות הטיפול? במחקרי המשך ניתן לבחון היבטים אלה ואולי בעתיד לייצר טיפול מקדים בחשיפה לא מודעת אשר ישלים את הטיפול הקיים היום בחשיפה.

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# Supplemental Experimental Procedures

**Participants**

Forty-eight healthy participants with normal or corrected normal visual acuity from the department of Psychology participated in the current experiment for course credit (37 women, 38 right-handed, mean age = 25, SD = 1.33). Seven participants who did not have measurable responses to the shocks were not included in the data analysis (SCR Score>0.2). Participants were randomly assigned to one of three groups: a group that underwent awareness exposure (n=13), a group that underwent unawareness exposure (n=14), and a group that did not undergo any exposure.

The experiment was validated by the Ethics Committee of Ben-Gurion University. Participants signed an informed consent form before partaking in the experiment and completed a filter question to ensure that the participants in the current experiment had no psychiatric or neurologic history.

**Stimuli and Apparatus**

Participants performed the experiment in a slightly darkened room. The stimuli were presented via E-Prime Software on a 19-inch Samsung screen with 60 HZ refresh rate and 1024\*768 resolution. Participants’ heads were supported by a chinrest, which was located at a distance of 61 cm from the screen. On the screen, participants were presented with conditioned stimuli (CS+ and CS-).

A scared face of a man and a scared face of a woman were presented. Pictures were selected from the NIMSTIM Database (Tottenham et. al., 2009). The choice to utilize facial expressions of fear was supported by previous studies. For example, simulation studies have found that the amygdala plays a vital role in the identification and evaluation of scared facial expressions (Adolphs et. al., 1994; Whalen, 1998). Researchers have also shown that these identification and evaluation processes can occur even without any relation to attention (Öhman, 2001) and awareness (Esteves et. al., 199).

The experiment included two stages, the acquisition stage and extinction stage, which will be specified in the procedure section. Participants in each of the three groups were exposed to the same two stimuli in the acquisition stage (Figure A). In the extinction stage, the group that underwent aware extinction and the group underwent unaware extinction, were exposed to the same picture that they were exposed to in the acquisition stage (Figure A). Participants in the control group, the group that did not undergo extinction, were presented with a scrambled face picture (Figure B).

The scrambled face stimulus was identical to the picture presented in the other two experiment groups, only that in this condition it was cut into a matrix of 7 \* 6 parts that were then mixed together using Matlab software.

The stimuli in all three groups were black-and-white, and were of identical contrast and luminance degree. Additionally, the stimuli were presented on top of a black background. The pictures were blurred at the tips by using Photoshop software and were surrounded by black-and-white rectangle frames, as depicted in Figure 2.

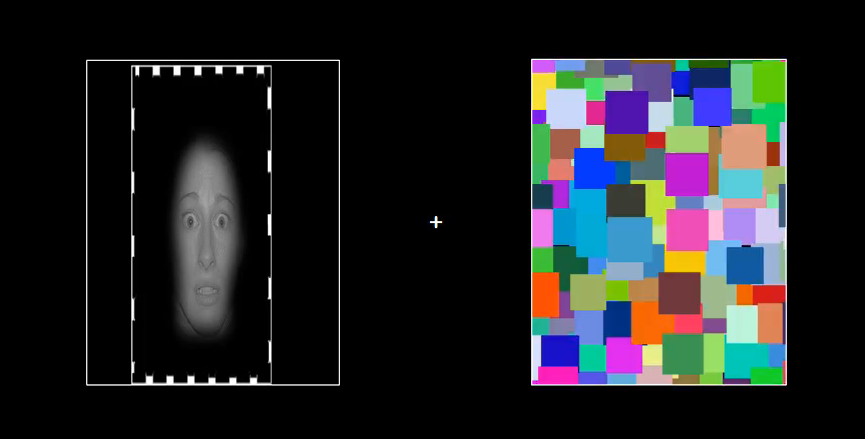


Figure A.

The man's and woman's face were partially associated with the unconditioned stimuli ( a mild electric shock) and participants’ skin conductance responses were measured. The electric shock was transferred to the participant via STMEPN system of Biopac Company. The system includes a STMISOLA slider and a USB component enabled the communication between the shocker appliance and the EPrime software. The power of the electric shock was in the range of 0-50 and the shock’s duration was 200 milliseconds. A snap electrode with isotonic gel was attached to the participants’ arms.

Skin conductivity was measured using the 150 MP system of the Biopac GSR100C Company. For GSR recordings, electrodes were attached to the forefinger and the forearm on each participant’s left hand. The samples of the subjects were collected with Acknowledge system of Biopac Company.

Stimuli via stereoscope were produced by Stereo Aids (Western Australia), and separate images were presented to each eye. This is described in further detail in the procedure section.

**GSR Analysis**

SCR waveforms were analyzed offline, using Acknowledge 3.9 software (BIOPAC Systems Inc.). SCR amplitudes to the conditioned and unconditioned stimuli were the dependent measures of conditioned and unconditioned responses, respectively. The level of SCR was determined by taking the base-to-peak difference for the first waveform (in microsegments, ms) during the 0.5–4.5s window after stimulus onset. The minimal response criterion was 0.02ms. The raw SCR scores were square-root transformed to normalize distributions. These normalized scores were scaled according to each participant’s unconditioned response by dividing each response by the mean square-root transformed unconditioned stimulus response.

**Experimental Procedure**

The experiment included two stages: acquisition and extinction.

Acquisition. All participants took part in this stage. Participants were attached to a shocker and a skin conductivity system. The power of the shock was defined according to the participant, under the guidance “to establish a level of shock that is highly annoying but not painful.”

After the calibration stage, participants were presented with a picture of a man or a woman and, at the same time, an electric shock was delivered to them. Participants were instructed to concentrate on the screen and try to understand the connection between the appearance of the picture and the electric shock. The electric shock appeared randomly about 0.5-4.5 seconds from the moment that the stimulus was presented. Between one stimulus and another, there was a time gap of 8-12 seconds. The electric shock was delivered when participants were presented with a CS+ stimulus, but never when presented with a CS- stimulus. The order of stimuli appearance was pseudo-randomized. In total, electrical shocks appeared in 33% of the steps in which CS + stimuli appeared (6 CS + with shock, 12 CS +, 12 CS-). At the end of this stage, the participants were presented with two diversion questions:

1. In this section, do you think that more pictures of women or men were presented?

2. What did you think while the shock was given?

It is known that, in a partial reinforcement array (that is, not every time CS + appeared, an electric shock was given), the acquisition process is slower. Nevertheless, this partial reinforcement procedure contributes to a slow decay process relative to a full reinforcement array.

Extinction. In the extinction stage, participants were assigned to one of the three groups: aware, unaware, no-extinction. This stage included 24 steps in which pictures were randomly presented (CS+ and CS-), and a post-test stage.

In the aware group, participants were overtly presented with the stimuli from the acquisition stage (the picture of the man/woman). In the unaware group and the no-extinction group, the CFS technique was used. The unaware group was presented with the stimulus from the acquisition stage to one of their eyes and, at the same time, a flickering stimulus of colored squares (Mondrian) was presented to their other eye. The no-extinction group was presented with a stimulus from the acquisition stage, but in a scrambled configuration (more details are provided in the previous section). In both groups, in each step after the presentation of the screened stimuli, participants were asked two questions in order to confirm their level of awareness to the stimulus:

1. Was the picture presented of a man or a woman?
2. How sure are you that you saw the picture? (1= “I did not see anything:” to 4= “I saw the picture clearly”).

By the end of the 24 steps, all three groups participated in the post-test stage. The post-step stage included three steps of the stimulation from the acquisition stage in order to examine how the stage of extinction affected participants’ responses.

After the post-test stage, there was a debriefing, which consisted of five questions:

1. What did you feel during the first stage in which you received electric shocks?
2. Did you think you would receive electric shocks in the second part of the experiment as well? When did you realize that you would not receive a shock?
3. Did you feel the same emotion that you felt in section A in the second part of the experiment? *If the subject answers no, ask why.*
4. Asking – was there a stage in which you thought about the shocks? Maybe in the last part?
5. In your opinion, what was the purpose of the experiment?

At the end of the debriefing, the subjects completed computerized questionnaires, which included BDI, OCI, STAI, DES.