# Part 3: General Discussion

This thesis intended to achieve several goals. First, it set out to test for unconscious threat extinction while assessing conscious experience of the suppressed stimuli, using two suppression techniques: CFS and VM. Since CFS allows for long-term stimulation, while VM allows for higher-level processing, the second aim of this study was to examine unconscious threat extinction by comparing these two methods. The third goal was to examine whether the phenomenon of unconscious threat extinction can be established in a controlled laboratory setting, while awareness is properly assessed. Thus, the various experiments presented in this work were conducting using measurements of awareness with objective and subjective indices. After establishing the phenomenon of unconscious threat extinction under laboratory conditions, the fourth aim of the present study was to examine its efficacy among subjects with symptoms of a specific phobia. Among this population, we also sought to test whether an increased dose of exposure to stimuli yields a better result among the subjects.

**Main results and conclusions of the current work**

The first part of the current work (2.1) dealt with evaluating the effectiveness of unconscious exposure to aversive stimuli using CFS, when awareness was properly controlled.

Despite our expectations that unconscious threat extinction could be demonstrated using this technique, we were unable to demonstrate either threat acquisition or threat extinction under laboratory conditions using CFS. This part of the current research was based on a series of studies by Siegel and Weinberger (2009, 2011, 2012; Siegel, 2017), and a study by Oyarzún et al (2019), which also failed to demonstrate unconscious threat extinction using SCR. It is possible that our inability to demonstrate this phenomenon using CFS lies in the mechanism of this technique. Several studies have found that the processing ability of this technique is limited relative to other masking techniques, and that backward masking might be more sensitive for measuring unconscious high-level processing than interocular suppression (20).

The second part of this work (2.2) focused mainly on examining whether unconscious threat extinction is possible under the VM paradigm. The results of this study suggest that unconscious threat extinction can take place using the VM technique. The finding that threat extinction can occur outside of consciousness has theoretical implications. One of the key models in threat acquisition and extinction is inhibitory learning. One of the main strategies that supports the inhibitory learning model is expectancy violation. This strategy is based on the premise that the gap between expectations and results is critical to learning new expectations, which will compete with previous expectations. However, since learned threat extinction is based on the formation of non-coincidental relationships between conditioned and unconditioned stimuli, awareness of the stimuli and the absence of the unconditioned stimulus is considered essential (Craske, 2014). The findings of this experiment suggest that, contrary to what the theory predicts, a threat extinction process may occur even with a lower degree of awareness.

The second part of this research also examined whether an individual’s level of anxiety influenced the accessibility to unconscious threat extinction. In conducting research that could potentially serve as a basis for development of new therapeutic tools for anxiety sufferers, it is important to understand whether this population tends to have a stronger response to unconscious threat extinction than does a population that does not suffer from anxiety. The results of this study indicate that a group of subjects with symptoms of anxiety who were unconsciously exposed to the stimuli were more likely to respond to unconscious threat extinction, while subjects with no symptoms of anxiety tended to respond more strongly to threat extinction processes when exposed to overt stimuli. This study is underpowered, but it does hint at a trend that has been studied in the literature, and indicates that subjects suffering from anxiety pay more attention to faces that are presented subliminally, compared to faces that are presented openly (Fox, 2002; Mogg & Bradley, 1999).

In the third and final part of this work (2.3), unconscious threat extinction using VM was examined among subjects with symptoms of a specific phobia. The findings indicate that the subjects’ degree of distress was reduced through unconscious threat extinction. This could be used to develop a therapeutic tool that could be added to the treatment protocols for anxiety disorders. In addition, the impact on the subjects of increasing the dose of unconscious threat extinction was examined. No differences in the level of distress or the degree of avoidance were found between subjects receiving the different doses. The findings of this chapter can provide the foundation for a therapeutic tool for anxiety disorders.

**Future directions of research**

The findings of the current work provide the basis for future research on unconscious threat extinction. The follow-up studies presented here will assist in understanding the phenomenon, and can improve the ability to develop therapeutic tools for anxiety disorders. In the present study, we were able to demonstrate unconscious threat extinction using a VM technique, but not using a CFS technique. Chapter 2.2 discussed how the processing of information by the subject can be influenced by spatial characteristics of the various stimuli (Gray et al., 2013; Yang et al., 2007) as well as temporal characteristics (Zhan, 2019; Zhu, 2016). These studies suggest that differing characteristics in terms of contrast and frequency of masked stimulation may influence the findings of the present study. In addition, an innovative variation of CFS, termed Real Life CFS, was recently developed (Korisky, 2018). Unlike standard CFS in which two-dimensional images (2D) are displayed on a screen, this version displays real physical objects. Studies show that real objects produce a stronger effect (Gomez et al., 2018; Snow et al., 2011; Snow et al., 2014). Thus, a follow-up study could examine whether unconscious threat extinction using this variation of CFS (with real spiders, for example) produces a stronger effect during unconscious perception.

An additional direction for future research is related to Virtual Environment (VE). VE has been studied and used in psychotherapy for treatment of a variety of conditions, including phobias (Carlin et al., 1997; Klein 2000; Mühlberger et al., 2006) and post-traumatic stress disorder (Difede 2002; Rizzo et al. 2005). There seems to be a trend towards using VE to replicate any part of the real world during the therapeutic process. Virtual spiders, for example, are used as stimuli to treat spider phobia (Carlin et al., 1997). Currently, VE uses a variety of VM techniques to hinder attention (Gonzalez-Franco & Lanier, 2017). One research group described successful experiments using VM in a virtual environment (Drummond et al., 2011). These findings suggest that, despite the difficulty inherent in developing this method, VM is possible within a stereoscopic VE (Drummond et al., 2011). It may be interesting for a follow-up study to examine whether the effect obtained in the present study using VR exists and can be manifest through VE, and thus constitute a therapeutic tool for use in the evolving world of virtual reality.

Another line of research is the examination of another emotion in addition to fear, namely disgust. 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 disgust (Woody & Teachman, 2000). Fear and disgust share a commonality: both of them are characterized as “negative affect” and both are expressed through an avoidance of the stimulus, out of fear of being injured (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). If disgust and fear can be clearly distinguished from one another, while they operate in a similar fashion, then the similarity and the distinction between the two may have practical implications (Woody et al, 2000) particularly , in the use of unconscious exposure for extinction of disgust in future studies.

Another future direction involves the relationship between distraction and unconscious threat extinction, and the contribution of unconscious threat extinction to the traditional therapy of exposure. Page et al. (1999, 2003) 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 an individual to feel that events and emotions are under one’s control, such that the person feels a sense of security and control in his or her 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). Whether the process of unconscious threat extinction is similar to the process of conscious threat extinction remains to be determined. However, another related question is whether people who undergo unconscious exposure, which is similar to distraction, function better, feel greater self-capability, and thus experience an increase in treatment efficacy. Perhaps, the combination of conscious and unconscious exposure might work in an additive or synergic manner. Future research might shed light on these possibilities, which may expand the translational implication of the current study.