**Exposure therapy theories**

The goal of exposure therapy is to facilitate threat extinction – the reduction in the conditioned fear response associated with feared stimuli (Abramowitz, 2013). Exposure is considered to be a clinical analogy of extinction learning, in which an aversive conditioned stimulus or situation is repeatedly represented without the predicted catastrophic consequences (e.g., de Voogd, & Phelps, 2019; Moscovitch, Antony, & Swinson, 2009; Weisman, &. Rodebaugh, 2018). The mechanisms underlying exposure are currently unknown, and there are several disputes about the factors that facilitate or obstruct symptom reduction (Podină, Koster, Philippot, Dethier, & David, 2013). The focusing of attention during exposure is one of the mechanisms examined as affecting the efficacy of exposure treatment, but its impact is still debatable.

Foa and Cossack's (1986) emotional processing theory states that focusing attention is crucial in minimizing fear. The results of exposure therapy, according to this model, are due to changes in the “fear structure” – a neural network that stores all aspects of stimulus characteristics as well as mental, physiological, and behavioral fear responses, including the cognitive evaluation. The relationships between the conditioned stimulus and the conditioned response are nullified when information that does not fit the current structure is presented. According to this model, complete activation of the fear structure requires attentional focus, which facilitates sensory coding of the phobic stimuli presented. Distraction techniques, on the other hand, inhibit the coding of relevant stimuli and thus the activation of the fear structure, as well as the emotional processing mechanism (Penfold & Page, 1999).

Inhibitory learning theory also supports attentional focus during exposure (Bouton, 1993; Craske et al., 2008). The mechanism of exposure therapy, according to this theory, is the acquisition and reinforcement of safe representations of the threatening stimulus. As a result of a mismatch between the patient's expectation and the outcome, fear decreases during exposure. New representations of the threatening stimuli are created as a result of such inconsistencies. During exposure, focusing attention on the threatening stimulus is critical because it helps one to process information about the non-threatening stimulus, resulting in the development of a new relationship between the stimulus and the response.

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 compliance rates is that patients consider confronting feared objects or situations as overly demanding. This highlights the need for novel interventions which may overcome this difficulty. It is possible that a new method of intervention may also make a theoretical contribution and shed light on the mechanism underlying exposure therapy.

## Fear conditioning without conscious awareness

In recent years, there has been cumulative evidence suggesting that fearful responses can occur without explicit stimulus presentation (Dimberg & Ohman, 1996; Ohman, 1986, 1993; Ohman et al., 2000a, Raio et al, 2012). One study found that images of fearful faces emerge into awareness faster than images of neutral or happy expressions, indicating that emotional expressions are unconsciously processed (Yang, Zald, & Blake, 2007). These results are supported by findings of increased amygdala activation in response to fearful faces as compared with masked images of happy faces (Whallen, 1998). Furthermore, these findings are in line with LeDoux’s (1996) suggestion that there is a direct path between the thalamus and the amygdala, which means that information may evoke fear even without activation of the visual cortex.

If learning can occur without explicit presentation of the stimulus, and fears can be acquired and experimentally provoked outside of awareness, it seems plausible that fears could diminish under similar conditions.

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

Although learning without explicit stimulus presentation had been previously demonstrated, it remains largely unknown whether fear can be reduced without explicit exposure. Nevertheless, several studies have tested whether subliminal exposure to images of spiders affects the willingness of people with spider phobia to approach a spider (Siegel & Weinberger, 2009; 2011).

Siegel and Weinberger (2009) developed the method known as Very Brief Exposure (VBE), which involves unconscious exposure to frightening stimuli via masking for a short period of time. In this method, subjects with a phobia of spiders were presented with a long series of masked images of spiders, each presented for a very short time. They found that this type of exposure reduced avoidance behavior among people who were afraid of spiders. Another study also found that unconscious exposure prompted subjects to approach the frightening stimulus (Weinberger, Siegel, Siefert, & Drwal, 2011). Moreover, a study by Siegel and Weinberger (2012) indicated that brief exposure to a masked frightening stimulus reduced avoidance of that stimulus to a greater extent than conscious exposure to it. This finding is consistent with previous studies showing that unconscious masked exposure to masked frightening stimuli has greater biological and behavioral effects than conscious exposure to that stimulus (Carlsson et al., 2004; Siegel & Weinberger, 2009). In their study of the effect of long-term unconscious exposure, Siegel and Weinberger (2012) found, that VBE reduced avoidant behavior and that this effect was maintained for two weeks. In a follow-up study, Siegel and Warren (2013) found that this reduction in avoidant behavior as a result of VBE was maintained even one year after exposure. However, two limitations underlie these studies. First, there is a question about the way awareness was measured and assessed, which I will expand on in Chapter 2.2. Second, in all the studies mentioned above, only behavioral metrics were used. One study used a physiological index, but no evidence for reduced physiological responses was obtained (Siegel, 2017). A recent study demonstrated the potential benefit of unconscious exposure using CFS (Oyarzún et al., 2019). In that study, fear reduction was registered via a measure of threat-potentiated startle responses, but not via Skin Conductance Response (SCR). Furthermore, the study lacked a control group for which no extinction took place.

**Acknowledgments**

As these final pages are being written, summarizing more than four years of work, I would like to thank everyone who helped me reach this exciting moment.

First and foremost, I would like to thank my supervisors, Prof. Gideon Anholt and Prof. Liad Mudrik. Thank you so much for your encouragement, kind words, and constant push to improve and persevere. Each of you, in your own special way, has shed light on new avenues and given me professional and personal tools.

Many thanks to Prof. Daniela Schiller of the Neuroscience Laboratory at Mount Sinai Hospital in New York, for her guidance, knowledge, and support from afar and up close.

Many thanks to the Department of Psychology, of which I have been a part for many years now, for the door that has always been open to me so I could consult about some graph or another, for the countless cups of tea, and for the outstretched hands that helped me carry computers and spiders. The warm embrace of Beersheba is always felt within the walls of our university buildings.

Many thanks to the wonderful members of my lab over the years, the dedicated research assistants, and the brave subjects.

Many thanks to my friends who have been with me for almost four decades, for their perceptive advice and humor. I am fulfilling a dream that began to take shape when we were very young, and you remind me of this whenever I feel I have lost my way.

Many thanks to my family, my inimitable parents, Moshe and Yehudit Avnieli, my brother Shai, and my sister Yael. All four of you are inspiring, each in your own field and with your many talents. Thank you so much for all the endless help along the way, and for being who you are. Many thanks to Atzmon and Osnat and to the entire Bachar family. Over the years you have also become my family. Thank you for the many conversations and your support.

And a final thanks to the four people dearest to my heart: Ira, you are my man, my friend, my wonderful partner in this life and in this achievement. To our three children – Barry, Gilad and Dan – you are my source of happiness, my pride and joy. I hope that with your endless curiosity and charm, you too will engage in a field that will be meaningful to you and that will enable you to contribute to society.

This work is dedicated with love and gratitude to my whole family, both close and extended.