The Impact of Fear Prediction and Fear Experience in Exposure-

Based Therapy for Panic Disorder With Agoraphobia

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Table of Contents

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1 Abstract

While habituation is a potential mechanism of action in exposure therapy, its explanatory value is limited. Contemporary perspectives emphasize the importance of expectancy violations in the context of exposure. Since the early conceptualization of fear generation and maintenance, expectation violation has been a focus, as demonstrated by Rachman's (1994) match-mismatch model. The match-mismatch model (Rachman, 1994) explores the discrepancy between expected fear and experienced fear, proposing that fearful individuals often overpredict the level of fear they expect to experience in a threatening situation. This overprediction bias might foster the development of anticipatory anxiety, avoidance behaviour, and safety behaviour, which in turn impedes the disconfirmation of feared outcomes (Hilleke et al., 2021). Despite the conceptual relevance of expectancies, there is a shortage of empirical studies examining their role within therapeutic treatments.

Working within the framework of the match-mismatch model (Rachman, 1994), the first article of this dissertation presents a systematic review of research examining the impact of expectancies. An analysis of 50 studies predominantly affirms the core assumptions of the match-mismatch theory. Most studies validate the existence of an overprediction bias in subclinical fears and anxiety disorders, coupled with a trend of reduction in both expected and experienced anxiety levels through repeated exposures. Predictions of fear improved with repeated exposure. Some findings suggest that greater accuracy in fear prediction correlates with a concurrent reduction in experienced fear. This hypothesis was subsequently tested in the empirical study, which was conducted within a clinical population.

Again within the framework of Rachman's (1994) match-mismatch model, the second article of this dissertation examines the role of violating expected and experienced fear as well as the effects of safety behaviour during in vivo exposure to panic disorder with agoraphobia. A total of 268 patients meeting DSM-IV criteria for panic disorder with agoraphobia participated in a manual-based cognitive behaviour therapy within the framework of a randomized multicentre study. Our findings revealed a tendency among participants to overpredict fear during exposure. However, contrary to expectations, the accuracy of fear predictions did not improve with practice. Moreover, the accuracy of predictions was not related to therapy outcome. Interestingly, the presence of safety behaviours did not yield significant effects on fear assessments. This study's result argues against the expectancy violation approach.

Taken together, the systematic review demonstrated evidence of overprediction, reductions in both expected and experienced fear, and increasing accuracy in fear predictions.

The second study confirmed the overprediction bias but did not find a correlation between improvements in fear prediction and treatment outcomes. Implications for future research and clinical practice are presented in a general discussion.

2 Introduction

Cognitive behavioural therapy is widely recognized as the most empirically supported treatment modality for panic disorder with and without agoraphobia (Bakker et al., 1998; Mitte, 2005; Ruhmland & Margraf, 2001; Heinrichs et al., 2009; Alpers, 2010; Kiropoulos et al., 2008; Lang et al., 2009). Exposure plays a fundamental role as a treatment component within the cognitive behavioural therapy framework. Repeated exposure exercises have emerged as an effective treatment component for panic disorder and agoraphobia (Hofmann & Smits, 2008; Olatunji et al., 2010; Sanchez-Meca et al., 2010). However, despite the demonstrated efficacy of this therapeutic approach, its fundamental mechanism of action remains unclear and is subject to ongoing discussion (Carey, 2011; Craske et al., 2014).

The role of habituation as a potential mechanism of action in exposure has been extensively examined, yet its explanatory power is surprisingly limited (Craske et al., 2014). Exposure effectiveness is often attributed to the activation of the fear system and the facilitation of subsequent habituation processes (Craske et al., 2008). Indeed, some studies indicate a correlation between initial fear activation or within-session habituation and treatment outcomes (e.g., Crits-Christoph et al., 2013; Rupp et al., 2016). While Craske et al. (2008) concluded that the evidence for this relationship is limited and mixed, safety and avoidance behaviours during exposure are also subject to ongoing debate (Parrish et al., 2008). Due to conflicting study results regarding safety behaviour, therapy manuals advocate contrasting treatment rationales (e.g., Schmidt-Traub, 2008; Schneider & Margraf, 1998).

Contemporary models increasingly emphasize the role of expectancy violation in the efficacy of exposure therapy (Craske et al., 2008; Craske et al., 2014; Rescorla & Wagner, 1972). Craske et al. (2008) proposed, within the framework of the inhibitory model, that the extinction of fear in exposure therapy occurs when an anticipated aversive outcome fails to occur during exposure. Here, the fear reduction deals with habituation and the learning of new associations that inhibit previously conditioned fear responses. More specifically, a conditioned response to a feared stimulus is weakened through repeated disconfirmation of the expected unconditioned threat.

Interestingly, expectancy violation was considered in early conceptualizations of fear development and maintenance, as evidenced by the match-mismatch model (Rachman, 1994), which examines expected and experienced fear. Stanley Rachman's (1994) model assumes that fearful individuals likely overpredict the fear they will experience in a threatening situation. This overprediction bias might contribute to the development of anticipatory anxiety, safety

behaviours, and avoidance behaviours, thereby impeding the disconfirmation of feared outcomes (Hilleke et al., 2021).

Several studies have confirmed the match-mismatch model of fear in the context of panic disorder and agoraphobia (Rachman et al., 1988; van Hout & Emmelkamp, 1994; Lavy et al., 1990; Schmidt et al., 1994). According to the match-mismatch model, the success of exposure treatment may not be solely dependent on repeated exposure. Instead, exposure should support individuals in recognizing a dissonance between their expectations and the actual outcomes of the exposure exercise.

Following a contemporary overview of panic disorder and agoraphobia, this dissertation's introduction explores the ongoing discussion regarding the mechanisms underlying exposure procedures. For this purpose, the section first outlines the mechanisms of action, limits of habituation, and current recommendations for implementing exposure procedures. Subsequently, newer cognitive theories and corresponding changes in their practical implementation are presented. The introduction closes with a presentation of the research questions.

3 Theoretical Background

3.1 Diagnostic Criteria, Prevalence, and Comorbidity of Panic Disorder and Agoraphobia

Panic disorder and agoraphobia are prevalent clinical disorders within the general population (Wittchen et al., 2010), and they are frequently present as comorbid conditions (Lang et al., 2018). The diagnostic criteria for panic disorder and agoraphobia are described below.

Following the Diagnostic and Statistical Manual IV (DSM-IV, American Psychiatric Association, 1994), panic disorder is defined by recurrent panic attacks, which are abrupt episodes of intense fear that reach their peak within ten minutes. Panic attacks are characterized by at least four accompanying symptoms, such as sweating, trembling, shortness of breath, and dizziness, among others. Furthermore, the individual must experience a persistent preoccupation with a noticeable change in behaviour for at least one month following the panic attack. Agoraphobia is characterized by an intense fear associated with specific situations, including public transport, open spaces, enclosed spaces, crowds, or being alone outside the home. In these settings, the fear of experiencing a panic attack is an underlying concern that makes it difficult for the individual to escape the situation. Consequently, entering such situations triggers a fear response, prompting the individual to avoid them altogether or to engage only when accompanied by others (American Psychiatric Association, 1994).

Research suggests that the onset of panic disorder commonly occurs between the ages of 20 and 30 (e.g., Kessler et al., 2006; Weissman et al., 1997). In women, incidence rates of panic disorder increase from age 10 to age 28 (e.g., Isensee et al., 2003). Burke et al. (1991) observed a bimodal age distribution in men, with the second incidence peak occurring in the 40s. In addition, findings from various studies show that agoraphobia without panic disorder often emerges earlier than panic disorder, with an average onset of 14 for girls and 16 for boys (Wittchen et al., 2008). Bienvenu et al. (2006) replicate these observations, indicating a higher incidence rate during adolescence than in later life stages.

The epidemiological catchment area (ECA) study conducted by Regier et al. (1990) estimated a lifetime prevalence of 1.6% for panic disorder and 5.2% for agoraphobia. In contrast, the National Comorbidity Survey Replication (NCS-R) led by Kessler et al. (2006) reported a lifetime prevalence of 3.7% for panic disorder without agoraphobia and 1.1% for panic disorder with agoraphobia. Additionally, the overall lifetime prevalence of panic attacks was reported to be 22.7%. A comprehensive review of the epidemiology of panic disorder and agoraphobia by Goodwin et al. (2005) reported a 12-month prevalence of 1.8% for panic disorder and 1.3% for agoraphobia without a history of panic. Wittchen and Jacobi (2005)

reported a 12-month prevalence of 3% for panic disorder in women and 1.7% in men, while agoraphobia affected 3.1% of women and 1% of men.

Goodwin et al. (2005) and Kessler et al. (2006) indicate that panic disorder rarely occurs in isolation in lifetime diagnoses. Several studies report frequent comorbidities with other mental disorders. Faravelli et al. (2004) found that depressive disorders, other anxiety disorders, and substance use disorders frequently co-occur with panic disorder. Similarly, Goodwin et al. (2004) identified a correlation between panic attacks and other anxiety disorders, substance use disorders, and somatoform disorders. Katerndahl and Realini (1997, 1999) further suggest that comorbid disorders may precede the onset of panic disorder. Finally, Goodwin et al. (2005) also reported an association between panic disorder and a higher incidence of physical illnesses (e.g., cardiovascular disease).

3.2 Models of the Development and Maintenance of Panic Disorder and Agoraphobia

The origins of anxiety were initially examined exclusively from a biological perspective. However, from the 1960s onward, a novel theoretical framework emerged, encompassing biological factors, biopsychological theories, cognitive models, conditioning theories, and the vulnerability stress model. The section outlines one of the most influential contemporary models.

In this integrative model of panic and agoraphobia, three categories of influence are recognized: predisposing vulnerabilities, triggering events, and maintaining mechanisms (e.g., Bouton et al., 2001). This model posits that general psychological characteristics, such as low tolerance for distressing sensations, heightened anxiety sensitivity, and certain cognitive styles, as well as biological susceptibility stemming, for example, from genetic vulnerability and temperament, interact with life stressors associated with panic symptoms. For example, in a study of patients with panic disorder, 80% reported experiencing negative life events, such as separation, loss experiences, and relationship problems, prior to their first attack (Doctor, 1982; Uhde et al., 1985; Barlow et al., 1984). These findings suggest that individuals experiencing panic attacks have elevated stress levels. In response to such stress, the body manifests physical symptoms, such as increased heart rate. The perceived threat of these symptoms triggers a bodily alarm reaction known as an initial panic attack, which activates the hypothalamic-pituitary-adrenal axis, and results in additional physiological symptoms such as increased respiratory rate, elevated heart rate, and heightened sweating. The pairing of unexpected alarm reactions with catastrophic thoughts leads individuals to perceive bodily symptoms as life-threatening. Through classical conditioning, these bodily symptoms become conditioned stimuli that subsequently provoke further panic attacks. This learning process contributes to the

persistence and chronicity of the disorder. Over time, patients may develop interoceptive awareness (e.g., increased awareness of their heartbeat), avoid activities that elicit physical symptoms (e.g., exercise, caffeine consumption, stair climbing), and show a general increase in physiological arousal.

As indicated in Section 3.1, the development of agoraphobia often follows panic disorder. Individuals who meet the diagnostic criteria for agoraphobia often report avoiding specific locations due to fear of experiencing a panic attack. Over time, this avoidance behaviour not only reinforces but also contributes to prolonged physiological arousal and a persistent perception of threat in the situations being avoided.

Cognitive behavioural therapy provides various approaches for treating panic disorders and agoraphobia. Beyond interventions targeting cognitive and behavioural aspects, addressing physical symptoms is a crucial element of the therapy. The therapeutic objectives are to facilitate new stimulus-response associations, cognitive restructuring, and improved understanding as well as tolerance of psychophysiological processes. The following section outlines the essential components of cognitive-behavioural therapy for treating panic disorders with agoraphobia.

3.3 Cognitive Behavioural Therapy in the Treatment of Panic Disorder with Agoraphobia

Cognitive behavioural therapy has consistently been found to be the most effective treatment for panic disorder with and without agoraphobia (Bakker et al., 1998; Mitte, 2005; Ruhmland & Margraf, 2001; Heinrichs et al., 2009; Alpers, 2010; Kiropoulos et al., 2008; Lang et al., 2009). Lang et al. (2009) note that cognitive-behavioural therapy typically includes treatment components such as psychoeducation, interoceptive exposure (IE), in vivo exposure, and cognitive therapy. Notably, agoraphobic avoidance has been identified as an important treatment target (Lang et al., 2009). Given the established effectiveness of this therapeutic component, prioritizing in vivo exposure as a core focus of treatment has been widely suggested (Heinrichs et al., 2009). This section outlines the treatment components of panic disorder and agoraphobia therapy based on the S3 guideline (Bandelow et al., 2021).

Psychoeducation aims to provide a better understanding of the disorder. Patients receive detailed information about common fears and physical symptoms associated with anxiety. Anxiety is described as a protective mechanism that initiates the fight-or-flight response in situations of imminent danger and is distinguished from pathological anxiety. Psychoeducation uses a vicious cycle model to explain the development and perpetuation of anxiety states. An important next step is to explain how safety and avoidance behaviours contribute to the

maintenance of anxiety disorders. Avoidance behaviour refers to the complete evasion of anxiety-provoking situations (e.g., refraining from using public transport). In contrast, safety behaviour includes strategies intended to reduce perceived danger (e.g., carrying medication, scanning for exits). Establishing therapy goals completes the segment on psychoeducation component.

Once the patient has understood the disorder model, the next phase of treatment involves interoceptive exposure, which aims to reduce fear of bodily symptoms. This involves intentionally inducing bodily symptoms through various exercises, such as spinning around or viewing dizziness-related images, without allowing the patient to resort to avoidance and safety behaviours. The deliberate triggering of symptoms enables the patient to realize that the symptoms do not yield the anticipated negative consequences, such as a heart attack. In addition, the regular repetition of these exercises aims to foster habituation to the body's symptoms, thereby rendering them less frightening over time. This framework encourages patients to refrain from previously relied-upon safety behaviours.

In vivo exposure is particularly effective in addressing agoraphobia. However, before starting this intervention, cognitive preparation is crucial to minimize therapy dropout. This phase involves delineating realistic anxiety scenarios after disorder model has been explained. Efficient preparation is essential for upcoming exposure sessions, and covers aspects such as stress management during exposure, therapeutic collaboration, and the promotion of independent implementation.

While exposure aims to reduce anxiety in specific situations through repeated confrontation, the elimination of avoidance and safety behaviours requires their active prevention during exposure. This is achieved by directly facing the fear-inducing situation. A situational hierarchy is collaboratively developed with the patient beforehand. In this regard, the exposure exercise is considered complete when the patient's anxiety has significantly reduced and the urge to escape is no longer present. It is recommended to repeat exposure sessions and to document each one.

Relapse prevention is the final pivotal component in treating panic disorder with agoraphobia. During this phase, the patient is informed about effective coping strategies for situations that pose a risk of relapse. The discussion address strategies for managing recurrent symptoms as well as lingering symptomatology. Emphasis is placed on stabilizing and transferring the achievements from previous therapy sessions, which is the most effective means of preventing relapses.

3.4 Mechanisms of Action of Exposure Therapy and Limitation of Habituation

This section discusses the mechanisms and limitations associated with exposure. As previously noted, exposure plays a central role in the cognitive treatment of panic disorder and agoraphobia; however, the precise mechanism underlying exposure remains a topic of debate (Carey, 2011). The theoretical foundation of exposure therapy, particularly its focus on habituation, is based on Foa and Kozak's (1986) network theory of emotional processing. According to this theory, exposure can modify the semantic structure of fear networks in which phobic stimuli and fear responses are represented. This process involves the integration of new, disconfirming information, leading to a reduction in fear responses. Foa and Kozak (1986) identified three key factors in this process: activation of the fear network, within-session habituation, and between-session habituation.

While some studies validate the link between habituation and a favourable therapy outcome, findings remain inconsistent. Rupp et al. (2016) found no evidence of a correlation between fear activation and therapeutic outcome. Craske et al. (2008) also found no correlation between initial fear activation, habituation within a session, and therapy outcome. Conversely, Crits-Christoph et al. (2013) identified significant correlations among fear activation, habituation, and therapy outcome. These discrepancies highlight the difficulty of drawing definitive conclusions about the role of habituation.

Moreover, several clinical phenomena cannot be fully explained by habituation alone. These include the reduction of anxiety during exposure therapy (Arch & Craske, 2009), the return of fear (e.g., Craske & Rachman, 1986; Craske & Mystkowski, 2006; Brown & Barlow, 1995; Fava et al., 2001), and the limited ability of extinction focused treatment studies to predict long-term outcomes (Plendl & Wotjak, 2010; Prenoveau et al., 2013; Rescorla, 2006; Baker et al., 2010; Culver et al., 2012; Kircanski et al., 2012). These observations raise the question of whether alternative or additional mechanisms may be responsible for the therapeutic effect of exposure. It is possible that mechanisms beyond habituation, such as expectancy violation, cognitive change, or inhibitory learning, play a more significant or more enduring role in reducing anxiety symptoms over time.

3.5 Current Recommendations for the Implementation of Exposure Therapy

As previously outlined in the explanation of exposure and prevention therapy (EPT), the importance of activating fear during treatment has been emphasized. Craske et al. (2008) demonstrated that a certain level of fear activation predicts treatment success. For example, a moderate level of fear activation has been deemed most favourable for achieving successful treatment outcomes (Meuret et al. 2012). Moreover, exposure should reduce anxiety within the

exposure session and through its repetitive application. Lang (2012) found that habituation between exposure sessions correlates with therapy outcomes. Repeated exposure exercises are recommended to strengthen the consolidation and retrieval of newly learned associations. In this context, Lang et al. (2012) found that patients who participated in multiple repeated exposure sessions achieved better outcomes.

Exposure treatment should be systematically structured to identify and test the patient's fears. In this regard, Salkovkis et al. (1999) demonstrated the effectiveness of using behavioural experiments to test expectations in the treatment of panic disorder and agoraphobia. The role of safety behaviours has also been a subject of ongoing discussion. Studies indicate that using safety behaviours induces less favourable treatment outcomes compared to when individuals abstain from such behaviours (Salkovskis et al., 1999; Salkovskis et al., 2006; Powers et al., 2004). However, some studies have reported contradictory findings (e.g., Penfold & Page, 1999; Oliver & Page, 2008; Sartory et al., 1989). Nonetheless, current recommendations advise that patients refrain from using safety behaviours during exposure sessions.

It is also recommended that exposure sessions be conducted across varied contexts. Research has shown that varying contexts reduce the risk of relapse into anxiety (Mystkowski et al., 2003). Shiban et al. (2013) found in a study of individuals with spider phobia that exposure to spiders in multiple contexts significantly decreased the recurrence of fear compared to exposure in only a single context.

3.6 Newer Approaches to Explaining the Mechanisms of Action in Exposure Therapy

Recent perspectives further highlight the importance of expectation violation within exposure therapy (Craske et al., 2008; Craske et al., 2014; Rescorla & Wagner, 1972). Craske et al. (2008), based on inhibitory learning, argue that fear extinction in exposure therapy occurs when an expected aversive event does not occur. According to Craske et. al (2008) patients must therefore experience the feared situation as less threatening than anticipated and repeat this process until their predictions align with the experienced level of fear, so that their fear responses becomes more predictable.

Further studies underscore that the way in which exposure is conceptualized and communicated significantly impacts therapy outcomes. In Salkovskis et al. (2006) exposure therapy groups were divided into two groups: one focused on the habituation process and another on disconfirming catastrophic thoughts and avoiding safety behaviours. The exposure group that emphasized disconfirmation of catastrophic fears and safety behaviours outperformed the group that focused on habituation. Here, refraining from safety behaviours is essential because it is the only means to accurately test catastrophic thoughts (Salkovskis, et al.,

1996; Salkovskis, et al., 1999). Integrating corrective information that contradicts existing anxiety structures appears to be a core element of exposure therapy.

The inhibitory learning model of exposure therapy (Craske et al., 2014, 2018, 2022), based on the principles of fear conditioning and extinction learning (Bouton, 1993; Miller & Matzel, 1988; Wagner, 1981), views pathological fear as a conditioned response to a conditioned stimulus, formed through its association with an expected unconditioned threat. In panic disorder, for example, panic attacks are believed to occur when interoceptive stimuli become linked with a perceived threat (Bouton et al., 2001; Barlow, 2002). Craske et al. (2008) proposed that significant fear reduction in exposure therapy is likely to occur when there is a discrepancy between anticipated and actual outcomes, particularly when patients realize that the anticipated threat does not occur.

Similarly, the match-mismatch model (Rachman, 1994) proposes that fearful individuals often overpredict the level of fear they will experience in a threatening situation (see also Rachman (1994) and Hilleke et al. (2021)). Rachman's (1994) original match-mismatch model comprises six hypotheses: 1) Fearful individuals tend to overpredict the intensity of fear they will experience in a threatening situation (overprediction bias). 2) The accuracy of fear prediction increases with practice. 3) If the predicted fear exceeds the experienced fear, subsequent fear predictions decrease. 4) If the experienced fear exceeds the predicted fear (underprediction of fear), subsequent fear predictions increase. 5) If the predicted and experienced fear match, fear predictions remain unchanged. 6) The experienced fear decreases with repeated exposure, regardless of the accuracy of previous predictions. Several studies have empirically validated the match-mismatch model of fear in panic disorder and agoraphobia (Rachman et al., 1988; van Hout & Emmelkamp, 1994; Lavy et al., 1990; Schmidt et al., 1994).

An additional factor to consider is the potential influence of both avoidance and safety behaviours. Craske et al. (2008) suggest that distraction interferes with expectation change, resulting in minimal or no new learning. Supporting this view, several studies have shown that overpredicted fear often leads to avoidance behaviour (e.g., Cox & Swinson, 1994; Craske & Barlow, 1988; Telch et al., 1989). Avoidance prevents individuals from realizing that their fear was overestimated (Craske et al., 1988). Consequently, avoidance may exacerbate the overprediction bias, as no correction of predicted fear occurs. Distraction, as a form of safety behaviour, is particularly problematic because it reduces awareness of the conditioned stimulus (CS) and its non-contingency with an unconditioned stimulus (US). To promote corrective learning, expectations should be directly violated through exposure conditions that maximize

expectation violation (see Craske et al., 2014). This expectancy-refutation approach warrants further empirical investigation.

3.7 Further Need for Research on Expectation Refutation

To advance further research on expectancy change in anxiety treatment, the first necessary step is to review the existing literature and findings. In particular, such investigations should assess whether a correlation exists between fears, expectations, and the accuracy of fear prediction. In addition, they should explore whether there are potential implications for therapeutic outcomes.

Future clinical research should examine the role of expectancy change during in vivo exposure across various anxiety-related clinical populations. As mentioned in Section 3.3, the effectiveness of exposure treatments has been well documented in the context of panic disorder and agoraphobia. Currently, empirical data on expectancy processes in these disorders remain scarce.

A frequently supported hypothesis is that individuals with anxiety tend to overpredict their fear in threatening situations (see Hilleke et al., 2021). This hypothesis should be examined in panic disorder and agoraphobia. In a next step, studies should investigate how the overprediction of fear develops over time in each individual considering whether prediction accuracy increases with repeated exposure and whether it influences therapeutic outcomes. As safety and avoidance behaviours may negatively impact exposure therapy, their influence should be monitored throughout the exposure sessions. Future research should also explore how expectation accuracy, its development, and the reduction of safety and avoidance behaviours jointly contribute to lasting therapeutic change.

4 Questions and Methods

4.1 Derivation of the Questions

This thesis examines the role of expectancy in exposure therapy, drawing upon the match-mismatch model proposed by Rachman (1994). In summary, this model, which has previously been tested in various subclinical anxieties and anxiety disorders, examines the role of expectancy in overprediction bias and whether repeated exposure increases the accuracy of expected and experienced fear. As empirical evidence regarding the match-mismatch model is lacking in clinical samples, further research is needed to determine its validity. This thesis presents two studies that address this gap.

The first study is a comprehensive review that describes and summarizes the current scientific findings regarding the match-mismatch model, focusing on pathological and semi-pathological fears. In particular, it explores the influence of prediction on therapy outcomes as an additional research question. This review serves as the theoretical foundation for subsequent empirical investigation, which is conducted in study two.

The second study empirically tests the match-mismatch model in a clinical sample of patients with panic disorder with agoraphobia. It examines the overprediction bias and the accuracy of predicted and experienced fear. Given the limited data on therapy outcomes, one hypothesis investigates whether the accuracy of fear predictions influences therapy outcomes. Empirical evidence shows that safety behaviour negatively impacts exposure therapy results. Thus, this study also investigates whether safety behaviour influences prediction accuracy.

Within this context, the following main research questions are posed:

1) Do individuals with anxiety expect higher levels of anxiety?

2) Does the accuracy of anxiety prediction change with repeated exposure exercises?

3) Does the accuracy of anxiety prediction influence therapy outcomes?

4.2 Methods

The initial phase of the survey involved compiling current empirical findings on the hypotheses of Rachman's match-mismatch model, focusing on pathological and semi-pathological fears. These results were subsequently documented, evaluated, and discussed. To answer the research questions, a multicentre study was conducted. This study is described in the following section.

4.2.1 Study 1: Match or mismatch? The impact of expected fear on experienced fear during exposure

This study was published under the following reference:

Abstract

Expectancies are assumed to play an essential role in the maintenance and treatment of anxiety disorders. The present review aimed to systematically summarize studies examining the effects of expectancies as suggested by the match-mismatch model of fear (Rachman, 1994). A total of 50 articles were included. The findings largely supported core assumptions of the match-mismatch theory. The majority of studies verified the existence of an overprediction bias in anxiety disorders and a reduction of both expected and actually experienced level of fear with repeated exposures. There was some evidence, that an increasingly accurate prediction of fear was associated with reductions in experienced fear. New research directions and clinical implications are proposed to further develop treatment strategies for anxiety disorders.

In the first study, the theoretical foundations of Rachman's match-mismatch model were examined and an overview of existing empirical findings on the model in subclinical anxiety and anxiety disorders was provided. The review results showed that most findings supported the model's assumptions. However, some studies contradicted or partially confirmed its hypothesis.

The literature review revealed that many of the existing studies are relatively outdated. This raises concerns about their findings being influenced by obsolete experimental designs or the potential neglect of important influencing factors, which could limit the validity and interpretability of previous findings.

Research on the match-mismatch model using clinical samples is limited. This gap makes it difficult to evaluate the model's relevance in clinical practice and the role of fear prediction in exposure therapy.

Against this background, the second study of this thesis utilizes the findings of the first study, while aiming to test the hypotheses of the match-mismatch model using a clinical sample. Specifically, this study investigates patients with panic disorder with agoraphobia using a structured manual-based therapy approach.

4.2.2 Study 2: How do patients` fear prediction and fear experience impact exposure-based therapy for panic disorder with agoraphobia? A comprehensive analysis of fear prediction.

This study was published under the following reference:

Abstract

Expectancy violation has been proposed as a potential core mechanism of action in psychotherapy, particularly in exposure therapy for anxiety disorders. However, various relevant expectations have been discussed, and empirical studies examining their significance are still scarce. This study aimed to investigate one specific form of expectancy violation, based on Rachman's (1994) match-mismatch model, specifically by comparing expected and experienced fear and examining their relationship to safety behaviour during exposure in vivo in 268 patients meeting DSM-IV criteria for panic disorder with agoraphobia. Participants underwent exposure to a highly controlled manual-based cognitive behaviour therapy in a randomized multicentre psychotherapy study. Participants tended to overpredict fear during exposure. Both expected and experienced fear significantly decreased over the course of repeated exposure exercises, while prediction (in-)accuracy (difference between expected and experienced fear) remained stable. The decrease in expected fear over time was a strong predictor of treatment outcomes for the BSQ and PAS at post. Even more, the reduction in expected fear was a significant predictor of treatment success across all outcome measures in the follow-up assessment. These findings suggest that violating excessive fear expectancies is not a necessary condition for symptom reduction during exposure therapy.

5 Conclusions

5.1 Main Findings From the Two Publications

The systematic review and the empirical study presented above addressed three research questions: the examination of a possible overprediction bias, the role of fear prediction during the therapeutic process and whether expectation violation, as per the match-mismatch model influences therapy outcomes.

The systematic review found that most studies confirmed an overprediction bias in clinical and subclinical fears and reported an improvement in prediction accuracy. In addition, the evidence suggests that more accurate fear prediction is associated with reductions in experienced fear. Given the evidence of the influence of expected fear on therapy outcomes and the observed changes in expected fear, the second study explored these hypotheses within a clinical sample. The clinical study revealed that in a threatening situation, individuals with anxiety overestimated the expected fear during their initial exposure session. Contrary to expectations, prediction accuracy did not improve with practice, nor did changes in prediction influence treatment outcomes. However, the changes in both expected and experienced fear were significantly related to treatment outcomes. Moreover, there was no discernible relationship between the use of safety behaviours and prediction accuracy. These results suggest that reducing fear expectations may not be crucial for symptom improvement during exposure therapy. Nonetheless, future studies should test this model with additional clinical samples including various anxiety disorders.

5.2 Theoretical and Empirical Integration of Findings

First, the findings partially support Rachman's (1994) match-mismatch model, confirming an overprediction bias in both the reviewed studies and the clinical study. This bias is particularly pronounced in anxious individuals, aligning with Davey's (1992) theory that such individuals maintain negative expectations before encountering fear-relevant stimuli. The review reveals that a consistent overprediction bias in anxious individuals gradually diminishes with repeated fear exposure. Most studies in the review reported improved accuracy in anxiety predictions (e.g., Arntz et al., 1994; Telch et al., 1994; Rachman & Lopatka, 1986a). However, this pattern was not observed in the clinical study. Although both expected and experienced anxiety levels decreased, the discrepancy between them remained stable, a finding consistent with van Hout and Emmelkamp (1994). For further exploration we examined whether expected anxiety, experienced anxiety, and the discrepancies between them correlated with therapy outcomes. The core finding was that anxiety prediction accuracy did not improve with the number of exposure trials during treatment, nor was it significantly correlated with treatment

outcomes. Conversely, reductions in both expected and experienced fear were significantly related to treatment success. The reduction in expected fear emerged as a predictor of treatment success at both post- and follow-up assessments.

Despite the repeated exposures, the overprediction bias persisted, even as experienced fear levels declined. Notably, exposure situations varied, progressing from taking a bus, to visiting a supermarket, to entering a forest, and ending with engagement in two individualized exposure scenarios. Even when analyzing specific situations (e.g., bus exposure), prediction accuracy did not improve significantly. Additionally, previous studies have sometimes found conflicting results regarding changes in prediction accuracy. For example, Telch et al. (1994) observed an increase in matchers, patients whose anxiety predictions became more accurate, though some continued to overpredict their fear despite overall reductions in expected and experienced fear. In contrast, van Hout and Emmelkamp (1994) found no improvement in prediction accuracy, with the discrepancy between predicted and experienced fear remaining stable throughout therapy. Participants in their study continued to overpredict fear following inaccurate predictions. Notably, earlier studies analyzed group-level trajectories rather than individual changes. These discrepancies might be partially explained by variability in initial overprediction levels. In samples with high initial overprediction, corrective experiences may have facilitated a convergence between expected and experienced fear. Conversely, in samples with more accurate initial estimates, factors such as safety behaviours might have maintained prediction inaccuracies, a hypothesis warranting further exploration.

Given previous findings that safety behaviours impact therapy outcomes (Helbig-Lang & Petermann, 2010), we examined their relationship with expected and experienced fear as well as their discrepancy between the two. However, our clinical study revealed no significant association between safety behaviour and prediction accuracy. Existing evidence generally suggests that safety behaviours increase discomfort and hinder exposure therapy outcomes (Helbig-Lang & Petermann, 2010). For example, Salkovskis et al. (1999) found that safety behaviours correlate with smaller reductions in cognitive distortions and anxiety levels. One possible explanation of our different results is that our measurement only differentiated between the use and non-use of safety behaviours, rather than capturing specific types or intensities of use. Future studies should explicitly explore safety behaviours. Furthermore, distinguishing between the types of expectation, such as the likelihood of a catastrophic event (see Pittig et al., 2023) or the intensity of fear (match-mismatch model), could provide deeper insight into safety behaviours. If individuals anticipate a catastrophic outcome, this may heighten fear responses and promote reliance on safety behaviours.

5.3 Main Conclusion

The systematic review and the clinical study confirmed that anxious individuals, particularly patients with panic disorder with agoraphobia, often overpredict their anxiety before encountering fear-provoking stimuli. In most reviewed studies, anxiety prediction accuracy improved with repeated exposure. However, this improvement did not occur in the clinical study. Instead, expected and experienced fear were analyzed separately, both showing improvement with increasing exposure sessions.

A notable approach in the review examined the difference between expected and experienced fear in relation to therapy outcomes. The underlying premise was that more accurate anxiety predictions may contribute to greater therapeutic success. However, the clinical study did not establish a direct correlation between prediction accuracy and therapy outcomes. Rather, reductions in both expected and experienced fear were associated with better therapy results. Thus, based on the clinical study findings, prediction accuracy alone does not appear to be a decisive factor for therapeutic success.

5.4 Clinical Implications

In clinical practice, addressing the persistence of overprediction throughout exposure therapy is imperative. Expectations regarding anxiety-provoking situations should be carefully examined, validated, and explicitly addressed. Given the notable dropout rates in psychotherapy, this issue warrants further investigation. While exposure therapy is highly effective for anxiety disorders, some individuals fail to benefit from it, and others discontinue treatment prematurely. Therefore, enhancing therapy effectiveness remains essential.

Providing cognitive clarification before exposure may be beneficial. In this respect, evaluating the likelihood of the inidividual's anxious thoughts materializing could help reduce catastrophic thinking and increase engagement in exposure. However, research on this issue is mixed. Craske et al. (2014) argued that pre-exposure cognitive work might interfere with expectation violation and hinder new learning. Conversely, Buchholz et al. (2022) found no significant differences in outcomes among individuals with spider phobia who engaged in cognitive work either before or after exposure. For some anxiety disorders, cognitive clarification before exposure may be particularly important and effective. When an individual overestimates fear intensity or the likelihood of catastrophe, it may be justified to address actual probabilities in advance.

Although our study did not identify a direct relationship between safety behaviours and anxiety overprediction, we recommend encouraging patients to reduce their reliance on safety behaviours (see Helbig-Lang & Petermann, 2010; Powers et al., 2004). There is some evidence

that exposure therapy is more effective when safety behaviours are restricted (e.g., Milosevic & Radomsky, 2013).

One potential approach involves addressing catastrophic expectations systematically through desensitization or graduated in vivo confrontation. This may reduce dropout rates by enabling patients to experience corrective learning, demonstrating the exaggerated nature of their fears. Alternatively, therapists may initially permit the use of safety behaviours (e.g., allowing patients to bring a "safety object" into feared situations), with the ultimate goal of gradually phasing them out. However, the risk remains that patients will become overly reliant on these behaviours, thereby reinforcing their anxiety. Research suggests that greater use of safety behaviours is associated with reduced learning rates during exposure therapy (Helbig-Lang & Petermann, 2010; Powers et al., 2004).

Furthermore, key principles of habituation theory remain relevant. Foa and Kozak (1986) emphasize three core indicators for exposure therapy: (1) fear activation, ensuring that genuine fear is triggered for reduction; (2) within-session fear reduction; and (3) between-session fear reduction. Varying exposure contexts can also enhance generalization and help maintain treatment gains (Mystkowski et al., 2003).

5.5 Final Consideration

Taken together, exposure therapy for anxiety disorders requires ongoing refinement to address individual variability and reduce high dropout rates. Strategies such as addressing the overprediction of fear, managing safety behaviours, developing anxiety hierarchies, and incorporating cognitive clarification may enhance therapy outcomes. Adhering to core principles of habituation, such as fear activation and progressive anxiety reduction, remains essential for optimizing exposure therapy.

6 Outlook

This thesis contributes to a more nuanced understanding of fear prediction in exposure therapy. While the findings provided limited support for Rachman's (1994) match mismatch model, they underscore the need for further clinical research. Future studies should build on recent methodological advances, especially in the documentation of clinical diagnoses and detailed assessment of safety behaviours. Why patients persistently overpredict fear despite experiencing reductions in anxiety remains a central open question. Different types of expectation, particularly threat expectancy (see also Pittig et al., 2023), should be examined in relation to treatment outcomes.

Moreover, the role of safety behaviours requires further empirical investigation. It may be useful to explore differentiated forms of safety behaviours, such as those aimed at managing

anxiety symptoms versus those intended to prevent feared catastrophes, and to assess their effects on learning processes in exposure. Gradual fading strategies, as well as timing and contextual effects, may offer practical approaches for improving engagement and outcomes in therapy.

In conclusion, while the match-mismatch model provides a valuable perspective on expectancy processes in anxiety disorders, it represents just one part of a broader theoretical framework. Future research should continue to disentangle the mechanisms through which expectancies influence therapeutic outcomes.

7 References

Alpers, G.W. (2010). Avoiding treatment failures in specific phobias. In M.W. Otto & S.G. Hofmann (Hrsg.), *Avoiding treatment failures in the anxiety disorder* (p. 209-227). New York: Springer Science + Business Media.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.

Arch, J.J., & Craske, M.G. (2009). First-line treatment: a critical appraisal of cognitive behavioral therapy developments and alternatives. *Psychiatric Clinics of North America, 32(3),* 525e547. http://dx.doi.org/10.1016/j.psc.2009.05.001

Arntz, A., Hildebrand, M., & van den Hout, M. (1994). Overprediction of anxiety, and disconfirmatory processes, in anxiety disorders. *Behavior Research and Therapy, 32(7),* 709–722. https://doi.org/10.1016/0005-7967(94)90028-0

Baker, A., Mystkowski, J., Culver, N., Yi, R., Mortazavi, A., & Craske, M.G. (2010). Does habituation matter? Emotional processing theory and exposure therapy for acrophobia. *Behaviour Research and Therapy, 48(11),* 1139-43. http://doi.org/10.1016/j.brat.2010.07.009

Bakker, A., van Balkom, A.J., Spinhoven, P., Blaauw, B.M. & van Dyck, R. (1998). Follow-up on the treatment of panic disorder with or without agoraphobia: a quantitative review. *The Journal of Nervous & Mental Disease, 186(7),* 414-419. DOI: 10.1097/00005053-199807000-00005

Bandelow, B., Aden, I., Alpers, G.W., Benecke, A., Benecke, C., Beutel, M.E., Deckert, J., Domschke, K., Eckhardt-Henn, A., Geiser, F., Gerlach, A.L., Harfst, T., Hau, S., Hoffmann, S., Hoyer, J., Hunger-Schoppe, C., Kellner, M., Köllner, V., Kopp, I.B., Langs, G., Liebeck, H., Matzat, J., Ohly, M., Rüddel, H.P., Rudolf, S., Scheufele, E., Simon, R., Staats, H., Ströhle, A., Waldherr, B., Wedekind, D., Werner, A.M., Wiltink, J., Wolters, J.P., & Beutel, M.E. (2021). *Deutsche S3-Leitlinie Behandlung von Angststörungen, Version 2.* AWMF. www.awmf.org/leitlinien/detail/ll/051-028.htm

Barlow, D.H. (2002). *Anxiety and its disorders. The nature and treatment of anxiety and panic* (2nd ed.). New York: Guilford Press.

Barlow, D.H., O`Brien, G.T., & Last, C.G. (1984). Couples treatment of agoraphobia. *Behavior Therapy, 15(1),* 41-58. https://doi.org/10.1016/s0005-7894(84)80040-4

Bienvenu, O.J., Onyike, C.U., Stein, M.B., Chen, L.-S., Samuels, J., Nestadt, G., & Eaton, W.W. (2006). Agoraphobia in adults: incidence and longitudinal relationship with

panic. *British Journal of Psychiatry, 188(5),* 432-438. http://doi.org/10.1192/bjp.bp.105.010827

Bouton, M.E., Mineka, S., & Barlow, D.H. (2001). A modern learning theory perspective on the etiology of panic disorder. *Psychological Review, 108(1),* 4–32. https://doi.org/10.1037/0033-295X.108.1.4

Bouton, M.E. (1993). Context, time, and memory retrieval in the interference paradigms of Pavlovian learning. *Psychol. Bull., 114(1),* 80-99. DOI:10.1037/0033-2909.114.1.80

Brown T.A & Barlow, D.H. (1995). Long-term outcome in cognitive-behavioral treatment of panic disorder: clinical predictors and alternative strategies for assessment. *Journal of Consulting Clinical Psychology, 63(5),* 754–765. doi:10.1037/0022-006X.63.5.754

Buchholz, J.L., Blakey, S.M., Hellberg, S.N., Massing-Schaffer, M., Reuman, L., Ojalehto, H., Friedman, J., & Abramowitz, J.S. (2022). Expectancy violation during exposure therapy: A pilot randomized controlled trial. *Journal of Behavioral and Cognitive Therapy, 32(1),* 13-24. https://doi.org/10.1016/j.jbct.2021.12.004

Burke, K.C., Burke, J.D., Rae, D.S. & Regier, D.A. (1991). Comparing age at onset of major depression and other psychiatric disorders by birth cohorts in 5 United-States community populations. *Archives of General Psychiatry, 48(9),* 789-795. http://doi.org/10.1001/archpsyc.1991.01810330013002

Carey, T.A. (2011). Exposure and reorganization: the what and how of effective psychotherapy. *Clinical Psychology Review, 31(2),* 236-248. http://doi.org/10.1016/j.cpr.2010.04.004

Cox, B.J., & Swinson, R.P. (1994). Overpredicion of fear in panic disorder with agoraphobia. *Behaviour Research and Therapy, 32(7),* 735-739. https://doi.org/10.1016/0005-7967(94)90030-2

Craske, M.G., & Barlow, D.H. (1988). A review of the relationship between panic and avoidance. *Clinical Psychology Review, 8(4),* 667–685. https://doi.org/10.1016/0272-7358(88)90086-4

Craske, M.G., Hermans, D., & Vervliet, B. (2018). State-of-the-art and future directions for extinction as a translational model for fear and anxiety. Philosophical Transactions of the Royal Society of London. *Series B, Biological Sciences, 373(1742),* 20170025. DOI: 10.1098/rstb.2017.0025

Craske, M.G., & Mystkowski, J. (*2006). Exposure therapy and extinction: clinical studies.* In M.G. Craske, D. Hermans, & D. Vansteenwegen (Eds.), *Fear and learning: Basic science to clinical application.* Washington, DC: APA Books.

Craske, M.G., & Rachman, S. (1986). Return of fear: heart rate responsivity and perceived skill. *British Journal of Clinical Psychology, 26(3),* 187-199. http://dx.doi.org/10.1111/j.2044-8260.1987.tb01346.x.

Craske, M.G., Rapee, R.M., & Barlow D.H. (1988). The significance of panic-expectancy for individual patterns of avoidance. *Behaviour Therapy, 19(4),* 577-592. DOI: 10.1016/S0005-7894(88)80025-X

Craske, M.G., Treanor, M., Conway, C.C., Zbozinek, T., & Vervliet, B. (2014). Maximizing exposure therapy: An inhibitory learning approach. *Behavior Research and Therapy, 58(1),* 10–23. https://doi.org/10.1016/j.brat.2014.04.006

Craske, M.G., Treanor, M., Zbozinek, T.D., & Vervliet, B. (2022). Optimizing exposure therapy with an inhibitory retrieval approach and the OptEx Nexus. *Behaviour Research and Therapy, 152(11),* 104069. https://doi.org/10.1016/J.BRAT.2022.104069

Craske, M.G., Waters, A.M., Bergman, L.R., Naliboff, B., Lipp, O.V., Negoro, H., & Ornitz, E.M. (2008). Is aversive learning a marker of risk for anxiety disorders in children? *Behaviour Research and Therapy, 46(8),* 954–967. DOI: 10.1016/j.brat.2008.04.011

Crits-Christoph, P., Gibbons, M.B., & Mukherjee, D. (2013). Psychotherapy process-outcome research. In M.J. Lambert (Ed.). *Bergin and Garfield`s handbook of psychotherapy and behaviour change* (6th ed., pp. 298-340). Oxford: John Wiley & Sons.

Culver, N., Stoyanova, M.S., & Craske, M.G. (2012). Emotional variability and sustained arousal during exposure. *Journal of Behavior Therapy and Experimental Psychiatry, 43(2),* 783-793. http://dx.doi.org/10.1016/j.jbtep.2011.10.009.

Davey, G.C.L. (1992). An expectancy model of laboratory preparedness effects. *Journal of Experimental Psychology, 121(1),* 24–40. https://doi.org/10.1037/0096-3445.121.1.24

Doctor, R.M. (1982). Major results of a large-scale pretreatment survey of agoraphobics. In R.L. DuPont (Ed.), *Phobia: A Comprehensive Summary of Modern Treatments* (pp.203-230). New York/Mazel, Inc.

Faravelli, C., Abradi, L., Bartolozzi, D., Cecchi, C., Cosci, F., D'Adamo, D., Lo lacono, B., Ravaldi, C., Scarpato, M.A., Truglia, E., & Rosi, S. (2004). The Sesto Fiorentino, Study: point and one year prevalences of psychiatric disorders in an Italian community sample using clinical interviewers. *Psychotherapy and Psychosomatics, 73(4),* 226-234. https://doi. Org/10.1159/000077741

Fava, G.A., Rafanelli, C., Grandi, S., Conti, S., Ruini, C., Mangelli, L., & Belluardo, P. (2001). Long-term outcome of panic disorder with agoraphobia treated by exposure.

Psychological   Medicine,   31(5),   891-898.   DOI: https://doi.org/10.1017/S0033291701003592

Foa, E.B. & Kozak, M.J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin, 99(1),* 20-35. http://doi.org/10.1037/0033-2909.99.1.20

Goodwin, R.D., Faravelli, C., Rosi, S., Cosci, F., Truglia, E., de Graaf, R., & Wittchen, H.-U. (2005). The epidemiology of panic disorder and agoraphobia in Europe. *European Neuropsychopharmacology,   15(4),   435-443.* http://doi.org/10.1016/j.euroneuro.2005.04.006

Goodwin, R.D., Lieb, R., Hoefler, M., Pfister, H., Bittner, A., Beesdo, K., & Wittchen, H.-U. (2004). Panic attacks as a risk factor for severe psychopathology. *American Journal of Psychiatry, 161(12),* 2207-2214. http://doi.org/10.1176/appi.ajp.161.12.2207

Heinrichs, N., Alpers, G.W., & Gerlach, A.L. (2009). *Evidenzbasierte Leitlinie zur Psychotherapie der Panikstörung und Agoraphobie.* Göttingen: Hogrefe.

Helbig-Lang, S., & Petermann, F. (2010). Tolerate or eliminate? A systematic review on the effects of safety behavior across anxiety disorders. *Clinical Psychology: Science and Practice, 17(3),* 218–233. https://doi.org/10.1111/j.1468-2850.2010.01213.x

Hilleke, M., Lang, T., & Helbig-Lang, S. (2021). Match or Mismatch? The Impact of Expected Fear on Experienced Fear During Exposure. Clinical Psychology: *Science and Practice, 28(2),* 148-160. https://doi.org/10.1037/cps0000005

Hofmann, S.G., & Smits, J. (2008). Cognitive-Behavioral Therapy for Adult Anxiety Disorders: A Meta-Analysis of Randomized Placebo-Controlled Trials. *The Journal of Clinical Psychiatry, 69(4),* 621-632. DOI: 10.4088/JCP.v69n0415

Isensee, B., Wittchen, H.-U., Stein, M., Höfler, B., & Lieb, M. (2003). Smoking increases the risk of panic. Findings from a prospective community study. *Archives of General Psychiatry, 60(7),* 692-700. http://doi.org/10.1001/archpsyc.60.7.692

Katerndahl, D.A., & Realini, J.P. (1999). Relationship between substance abuse and panic attacks. *Addictive Behaviors, 24(5),* 731-736. http://doi.org/10.1016/S0306-4603(98)00078-1

Katerndahl, D.A., & Realini, J.P. (1997). Comorbid psychiatric disorders in subjects with panic attacks. *Journal of Nervous and Mental Disease, 185(11),* 669-674. http://doi.org/10.1097/00005053-199711000-00003

Kessler, R., Chiu, W.T., Jin, R., Ruscio, A.M., Shear, K., & Walters, E.E. (2006). The epidiomology of panic attacks, panic disorder and agoraphobia in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 63(4),* 415-424. http://doi.org/10.1001/archpsyc.63.4.415

Kircanski, K., Mortazavi, A., Castriotta, N., Baker, A.S., Mystkowski, J.L., Yi, R., & Craske, M.G. (2012). Challenges to the traditional exposure paradigm: variability in exposure therapy for contamination fears. *Journal of Behavior Therapy and Experimental Psychiatry, 43(2),* 745e751. http://dx.doi.org/10.1016/j.jbtep.2011.10.010.

Kiropoulos, L.A., Klein, B., Austin, D.W., Gilson, K., Pier, C., Mitchell, J., & Ciechomski, L. (2008). Is internet-based CBT for panic disorder and agoraphobia as effective as face-to-face CBT? *Journal of Anxiety Disorders, 22(8),* 1273-1284. https://doi.org/10.1016/j.janxdis.2008.01.008

Lang, T., Helbig-Lang, S., Westphal, D., Gloster, A.T., & Wittchen, H.-U. (2018*). Expositionsbasierte Therapie der Panikstörung mit Agoraphobie.* Hogrefe: Göttingen.

Lang, T., (2012). *Expositionsfokussierte Behandlung zur Panikstörung und Agoraphobie: Untersuchungen zu Wirkfaktoren und Wirkmechanismen.* Unveröffentlichte Dissertation, Technische Universität Dresden.

Lang, T., Helbig-Lang, S., Gloster, A.T., Richter, J., Hamm, A.O., Fehm, L., Fydrich, T., Gerlach, A.L., Ströhle, A., Alpers, G.W., Gauggel, S., Kircher, T., Deckert, J., Höfler, M., Arolt, V., & Wittchen, H.-U. (2012). Effekte therapeutenbegleiteter versus patientengeleiteter Exposition bei Panikstörung mit Agoraphobie. *Zeitschrift für Klinische Psychologie und Psychotherapie, 41(2),* 114-124.

Lang, T., Helbig-Lang, S., & Petermann, F. (2009). Which interventions are crucial in CBT for Panic Disorder and Agoraphobia? – A Systematic Review. *Zeitschrift für Psychiatrie, Psychologie und Psychotherapie, 57(3),* 161-175. DOI: 10.1024/1661-4747.57.3.161

Lavy, E.H., van den Hout, M. A., & Arntz, A. (1990). Effects of matches and mismatches in agoraphobic and neutral situations. *Behavior Research and Therapy, 28(1),* 43–50. https://doi.org/10.1016/0005-7967(90)90053-L

Meuret, A.E., Seidel, A., Rosenfield, B., Hofmann, S.G., & Rosenfield, D. (2012). Does fear reactivity during exposure predict panic symptom reduction? *Journal of Consulting and Clinical Psychology, 80(5),* 773-785. http://doi.org/10.1037/a0028032

Miller, R.R., & Matzel, L.D. (1988). Contingency and relative associative strength. In S. B. Klein & R. R. Mowrer (Eds.), *Contemporary learning theories: Pavlovian conditioning*

and the status of traditional learning theory (pp. 61-84). Hillsdale, NJ: Lawrence Erlbaum Associates.

Milosevic, I., & Radomsky, A.S. (2013). Incorporating the judicious use of safety behavior into exposure-based treatments for anxiety disorders: A study of treatment acceptability. *Journal of cognitive psychotherapy, 27(2),* 155-174. https://doi.org/10.1891/0889-8391.27.2.155

Mitte, K. (2005). A meta-analysis of the efficacy of psycho- and pharmacotherapie in panic disorder with and without agoraphobia. *Journal of affective disorders, 88(1),* 27-45. DOI: 10.1016/j.jad.2005.05.003

Mystkowski, J.L., Mineka, S., Vernon, L.L., & Zinbarg, R.E. (2003).Changes in caffeine states enhance return of fear in spider phobia. *Journal of Consulting and Clinical Psychology, 71(2),* 243-250. http://doi.org/10.1037/0022-006X.71.2.243

Olatunji, B.O., Cisler, J.M., & Deacon, B.J. (2010). Efficacy of cognitive behavioral therapy for anxiety disorders: a review of meta-analytic findings. *Psychiatric Clinics of North America, 33(3),* 557-577. DOI: 10.1016/j.psc.2010.04.002.

Oliver, N.S., & Page, A.C. (2008). Effects of internal and external distraction and focus during exposure to blood-injury-injection stimuli. *Journal of Anxiety Disorders, 22(2),* 283-291. https://doi.org/10.1016/j.janxdis.2007.01.006

Parrish, C.L., Radomsky, A.S., & Dugas, M.J. (2008). Anxiety-control strategies: Is there room for neutralization in successful exposure treatment? *Clinical Psychology Review, 28*(8), 1400-1412. https://doi.org/10.1016/j.cpr.2008.07.007

Penfold, K., & Page, A.C. (1999). The effect of distraction on within-session anxiety reduction during brief in vivo exposure for mild blood-injection fears. *Behavior Therapy, 30(4),* 607-621. https://doi.org/10.1016/S0005-7894(99)80028-8

Pittig, A., Ingmar, H., Goerigk, S., Richter, J., Hollandt, M., Lueken, U., Pauli, P., Deckert, J., Kircher, T., Straube, B., Neudeck, P., Koelkebeck, K., Dannlowski, U., Arolt, V., Fydrich, T., Lehm, L., Ströhle, A., Totzeck, C., Margraf, J., Schneider, S., Hoyer, J., Rief, W., Craske, M.G., Hamm, A.O., & Wittchen, H.-U. (2023). Change of threat expectancy as mechanism of exposure-based psychotherapy for anxiety disorders: Evidence from 8.484 exposure exercises of 605 patients. *Clinical Psychology Science, 11(2),* 199-217. DOI: 10.1177/21677026221101379

Plendl W., & Wotjak, C.T. (2010). Dissociation of within and between-session extinction of conditioned fear. The *Journal of Neuroscience, 30(14),* 4990–4998. doi:10.1523/JNEUROSCI.6038-09.2010

Powers, M.B., Smits, J.A.J., & Telch, M.J. (2004). Disentangling the effects of safety-behaviour utilization and safety-behaviour availability during exposure-based treatment: A placebo-controlled trial. *Journal of Consulting and Clinical Psychology, 72(3),* 448-454. http://doi.org/10.1037/0022-006X.72.3.448

Prenoveau, J.M., Craske, M.G., Liao, B., & Ornitz, E.M. (2013). Human fear conditioning and extinction: timing is everything. or is it? *Biological Psychology, 92(1),* 59-68. http://dx.doi.org/10.1016/j.biopsycho.2012.02.005.

Rachman, S. (1994). The overprediction of fear: A review. *Behavior Research and Therapy, 32(7),* 683–690. https://doi.org/10.1016/0005-7967(94)90025-6

Rachman, S., Levitt, K., & Lopatka, C. (1988). Experimental analysis of panic-III. Claustrophobic subjects. *Behavior Research and Therapy, 26(1),* 41–52. https://doi.org/10.1016/0005-7967(88)90032-0

Rachman, S., & Lopatka, C. (1986a). Do fears summate?–III. *Behavior Research and Therapy, 24(6),* 653–660. https://doi.org/10.1016/0005-7967(86)90060-4

Regier, D.A., Narrow, W.E., & Rae, D.S. (1990). The epidemiology of anxiety disorders: The Epidemiologic Catchment Area (ECA) experience. *Journal of Psychiatric Research, 24*(2), 3-14. https://doi.org/10.1016/0022-3956(90)90031-K

Rescorla, R.A. (2006). Deepened extinction from compound stimulus presentation. Journal of Experimental Psychology: *Animal Behavior Processes, 32(2),* 135-144. http://dx.doi.org/10.1037/0097-7403.32.2.135. 135.

Rescorla, R.A., & Wagner, A.R. (1972). *A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and non reinforcement.* In A.H. Black & W.F. Prokasy (Eds.), Classical Conditioning II: current research and theory (pp. 64–99). Appleton-Century-Crofts.

Ruhmland, M. & Margraf, J. (2001). Efficacy of psychological treatments for panic and agoraphobia. *Verhaltenstherapie, 11(1),* 41-53. DOI: 10.1159/000050323

Rupp, C., Doebler, P., Ehring, T., & Vossbeck-Elsebusch, A.N. (2016). Emotional Processing Theory put to test: A meta-analysis on the association between process and outcome measures in exposure therapy. *Clinical Psychology and Psychotherapy, 24(3),* 697-711. http://doi.org/10.1002/ccp.2039

Salkovskis, P.M., Clark, D.M., & Gelder, M.G. (1996). *Cognitive-behaviour links in the persistence of panic. Behaviour Research and Therapy, 34(5-6),* 453-458. http://doi.org/10.1016/0005-7967(95)00083-6

Salkovskis, P.M., Clark, D.M., Hackmann, A., Wells, A., & Gelder, M.G. (1999). An experimental investigation of the role of safety-seeking behaviours in the maintenance of panic disorder with agoraphobia. *Behaviour Research and Therapy, 37(6),* 559-574. http://doi.org/10.1016/S0005-7967(98)00153-3

Salkovskis, P.M., Hackmann, A., Wells, A., Gelder, M.G., & Clark, D.M. (2006). Belief disconfirmation versus habituation approaches to situational exposure in panic disorder with agoraphobia: A pilot study. *Behaviour Research and Therapy, 45*(5), 877-885.

Sanchez-Meca, J., Rosa-Alcazar, A., Marin-Martinez, F., & Gomez-Conesa, A. (2010). Psychological treatment of panic disorder with or without agoraphobia: A meta-analysis. *Clinical psychological review, 30(6),* 815-817. DOI : 10.1016/j.cpr.2010.05.005

Sartory, G., Master, D., & Rachman, S. (1989). Safety-signal therapy in agoraphobics – A preliminary test. *Behaviour Research and Therapy, 27(2),* 205-209. doi: 10.1016/0005-7967(89)90081-8

Schmidt, N.B., Jacquin, K., & Telch, M.J. (1994). The overprediction of fear and panic in panic disorder. *Behavior Research and Therapy, 32(7),* 701–707. https://doi.org/10.1016/0005-7967(94)90027-2

Schmidt-Traub, S. (2008). *Panikstörung und Agoraphobie*. Göttingen: Hogrefe.

Schneider, S. & Margraf, J. (1998). *Agoraphobie und Panikstörung*. Göttingen: Hogrefe.

Shiban, Y., Pauli, P., & Mühlberger, A. (2013). Effect of multiple context exposure on renewal in spider phobia. *Behaviour Research Therapy, 51(2),* 68-74. doi: 10.1016/j.brat.2012.10.007.

Telch, M.J., Ilai, D., Valentiner, D., & Craske, M.G. (1994). Match-mismatch of fear, panic and performance. *Behavior Research and Therapy, 32(7),* 691–700. https://doi.org/10.1016/0005-7967(94)90026-4

Telch, M.J., Brouillard, M., & Telch, C.F. (1989). Role of cognitive appraisal in panic-related avoidance. *Behaviour Research and Therapy, 27(4),* 373-383. Doi: 10.1016/0005-7967(89)90007-7

Uhde, T.W., Boulenger, J.P., Roy-Byrne, P.P., Vittone, B.J., Geraci, M., & Post, R.M. (1985). Longitudinal course of panic disorder: clinical and biological considerations. *Progress in Neuropsychopharmacology and Biological Psychiatry, 9(1),* 39-51. http://doi.org/10.1016/0278-5846(85)90178-2

van Hout, W.J.P.J., & Emmelkamp, P.M.G. (1994). Overprediction of fear in panic disorder patients with agoraphobia: Does the (mis) match model generalize to exposure in vivo therapy? *Behavior Research and Therapy, 32(7),* 723–734. https://doi.org/10.1016/0005-7967(94) 90029-9

Wagner, A.R. (1981). SOP: A model of automatic memory processing in animal behavior. In N.E. Spear & R.R. Miller (Ed.), *Information processing in animals: Memory mechanisms* (pp. 5-47). Hillsdale, NJ: Erlbaum

Weissman, M.M., Bland, R.C., Canino, G., Faravelli, C., Greenwald, S., Hwu, H.G., Joyce, P.R., Karam, E.G., Lee, C.K., Lellouch, J., Lepine, J.P., Newman, S.C., Oakley-Browne, M.A., Rubio-Stipec, M., Wells, J.E., Wickramaratne, P.J., Wittchen, H.-U., & Yeh, E.K. (1997). The cross-national epidemiology of panic disorder. *Archives of General Psychiatry, 54(4),* 305-309. http://doi.org/10.1001/archpsyc.1997.01830160021003

Wittchen, H.-U., Gloster, A.T., Beesdo-Baum, K., Fava, G.A., & Craske, M.G. (2010). Agoraphobia: A review of the diagnostic classificatory position and criteria. *Depression and Anxiety, 27(2),* 113-133. http://doi.org/10.1002/da.20646

Wittchen, H.-U., & Jacobi, F. (2005). Size and burden of mental disorders in Europe - A critical review and appraisal of 27 studies. *European Neuropsychopharmacology, 15(4),* 357-376.

Wittchen, H.-U., Nocon, A., Bessdo, K., Pine, D.S., Höfler, M., Lieb, R., & Gloster, A.T. (2008). Agoraphobia and Panic. Prospective-longitudinal relations suggest a rethinking of diagnostic concepts. *Psychotherapy and Psychosmatics, 77(3),* 147-157. http://doi.org/10.1159/000116608

Wittchen, H.-U. & Pfister, H. (1997). *DIA-X Interview. Instruktionsmanual zur Durchführung von DIAX- Interviews [Instruction manual for the DIA-X interview].* Lisse, The Netherlands: Swets & Zeitlinger.