Great expectations: inhibitory learning and change processes in exposure therapy for PTSD

Kooistra, M.J.

Chapter 7

General discussion

In the previous chapters, we aimed to elucidate the mechanisms of change in exposure therapy for PTSD and to translate ILR principles into clinical practice. To this end, we analyzed data from treatment studies to establish a temporal link between proposed mechanisms and treatment outcomes, and we conducted experimental studies, designed to manipulate the proposed mechanisms through variations in therapeutic delivery. In the current chapter, I summarize the main findings, provide a critical discussion, examine limitations, and reflect on the implications for future research and clinical practice.

Summary of main findings

In **Chapter 2** we examined whether changes in posttraumatic cognitions temporally preceded changes in PTSD symptoms during PE in adult patients with PTSD following childhood abuse. Change in posttraumatic cognitions is a proposed mechanism through which exposure therapy leads to a reduction in PTSD symptoms. We found a bi-directional relationship between cognitions and symptoms, meaning that reductions in posttraumatic cognitions predicted decreases in PTSD symptoms, and vice versa. However, the effect of cognitions on symptoms was almost twice as great as the reverse effect. Our findings indicate that cognitive change (operationalized as general negative cognitions about the self, about the world and self-blame) precedes PTSD symptom reduction, although cognitive change and PTSD symptom change are not entirely distinct processes. Greater precision in measuring the specific cognitions that are targeted in treatment may help to elucidate which cognitive changes precede symptom reduction.

In **Chapter 3** we used the same dataset to examine whether in-session distress variability temporally precedes changes in PTSD symptoms during PE. According to ILR principles, variation in distress levels during exposure may facilitate extinction learning, thereby enhancing the effectiveness of exposure therapy. Capturing in-session distress variability in a way that aligned with its theoretical conceptualization (i.e., an up-and-down pattern of in-session distress levels) proved difficult, as existing metrics did not fully reflect this definition. Using several operationalizations of in-session distress variability, we found that none predicted subsequent PTSD symptom improvement during PE. In other words, greater distress variability within a given session was not associated with greater symptom reduction at the next session (i.e., no temporal or within-person effect). However, we did find that average distress variability across sessions (i.e., the between-person effect) was associated with greater overall symptom improvement. This suggests that distress variability may be a marker of who responds well to PE in general, rather than reflecting a mechanism of change of PE. A clinical implication is that distress variability may

not require explicit emphasis during sessions. Optimization efforts may be better directed at other proposed mechanisms, such as expectancy violation.

In **Chapter 4,** we took a closer look at the effect of expectancy violation on treatment outcomes. Using a one-session treatment paradigm, we assessed whether exposure with an explicit focus on expectancy violation resulted in better exposure outcomes compared to exposure without an expectancy focus, in a clinical sample of treatment-seeking patients with PTSD. Whether emphasizing expectancy violation leads to enhanced outcomes has not yet been studied in PTSD. We assessed exposure outcomes through fear-related responses to a personalized imagery task and a PTSD symptom questionnaire (PCL-5). On average, fear responses to the imagery and PTSD symptoms decreased from pre to post exposure session. We found no significant differences between conditions, indicating that the identification of negative expectancies and emphasizing their non-occurrence during exposure did not lead to enhanced immediate treatment outcomes. As we used a single-session paradigm, we were unable to assess potential effects over an extended period. This study revealed that emphasizing expectancy violation during (imaginal) exposure did not immediately affect outcomes. This does not rule out beneficial effects beyond the first session, however.

In Chapter 5, we evaluated the applicability and effects of a comprehensive ILR-adapted exposure therapy in PTSD patients using a single-case experimental (SCED) design. Although the ILR approach has been proposed as an improvement to exposure therapy, it is crucial to first determine whether a full ILR-based exposure can produce meaningful therapeutic effects. Participants in this study tracked negative expectancies, distress tolerance, and PTSD symptoms daily throughout baseline, treatment, and follow-up. We found that ILR-based exposure led to significant reductions in negative expectancies and PTSD symptoms. However, we found similar results for EPT-based exposure. Our findings indicate that ILR-based principles can be effectively applied to exposure therapy for PTSD, but there is no indication that these principles increase the efficacy of the treatment or uniquely affect its theorized change mechanisms.

Finally, in **Chapter 6**, we assessed the psychometric properties of the Threat Appraisal in PTSD Scale (TAPS), a measure we developed to evaluate concerns about concrete trauma-related negative outcomes. Although negative expectancies have been increasingly emphasized as playing a crucial role in the maintenance and recovery of PTSD, there was no valid measure to assess these. We found that the TAPS was a reliable and valid measure, making it a valuable contribution to the field. Patients seemed most concerned about items related to the factor 'losing control'.

The TAPS moderately correlated with more general posttraumatic cognitions, suggesting that they are related but different constructs.

Exposure therapy is not so easily optimized

Our findings consistently demonstrate the effectiveness of exposure therapy for PTSD (**Chapters 2, 3, 4**, and **5**), which is in line with a multitude of studies (see for meta-analyses: (Mavranezouli et al., 2020; McLean et al., 2022). The ILR approach to exposure was introduced with the idea that the implementation of its proposed strategies (e.g., maximizing expectancy violation, incorporating variability) would lead to enhanced treatment efficacy and less relapse (return of fear). Although we find that ILR principles can be effectively applied to exposure therapy for PTSD, we found no optimized exposure outcomes in this population and within the time frame investigated (**Chapters 3, 4,** and **5**).

Applying ILR principles to exposure for PTSD

The ILR approach is a clinical theory on the application of exposure therapy, grounded in findings from experimental fear conditioning studies, most of which have been conducted with healthy participants. We were the first to test ILR principles in PTSD treatment and translating these principles to the delivery of exposure therapy presented several challenges.

In Pavlovian fear conditioning research, the US is typically an external threat, such as an electric shock, that naturally elicits a fear response (Craske et al., 2014; Hermans et al., 2006; Pittig et al., 2018). In other words, the ILR principles are grounded in experimental paradigms where the feared outcome is concrete, and occurs (fairly) immediate. However, in PTSD the feared outcomes are not always concrete and immediate. For example, patients with PTSD frequently report relatively abstract expectancies, related to distress or internal threats, such as 'losing control' or 'going crazy' (de Kleine et al., 2017; Foa & McLean, 2016; Rothbaum et al., 2019; and also **Chapter 6**). Some patients are unable to articulate a feared outcome at all, beyond expressing that the exposure will be aversive, despite adequate inquiry by the therapist. Moreover, feared outcomes are sometimes long-term or unknowable (e.g., 'my body will eventually stop functioning'), which is also seen in patients with obsessive-compulsive disorder (Jacoby & Abramowitz, 2016). According to the ILR framework, such expectancies should be reframed into concrete and immediately testable outcomes. However, this is difficult when patients do not endorse fears that qualify as a US, a challenge also reported in two empirical studies with other (clinical) populations (Kennedy & Hawks, 2021; Scheveneels & Carpentier, 2025). There is considerable variation in the types of expectancies that are targeted in empirical studies on expectancy violation (e.g., concrete, abstract, internal, external,

idiographic, and predetermined/fixed). It remains unclear whether the application of the ILR approach to exposure therapy for PTSD is only meaningful for patients who report a clear US expectancy and whether this US needs to be biologically significant (e.g., impending death) or whether more vague expectancies (e.g., long-term damage) can also be targeted.

Another challenge in translating the ILR approach to PTSD is that the guidance provided by Craske and colleagues (2014, 2022) focuses solely on in vivo exposure, while imaginal exposure is a core component of exposure therapy for PTSD. Empirical studies on expectancy violation have similarly focused on in vivo procedures (Baker et al., 2010; De Jong et al., 2023; Deacon et al., 2013; Krause et al., 2022). Expectancies related to external threat (e.g., 'the perpetrator will attack me again') may be best tested in vivo, whereas expectancies related to internal threat (e.g., 'I will lose my mind') can be tested during imaginal exposure. As mentioned above, expectancies related to this internal threat can also be less concrete and immediate. Interestingly, two studies on virtual reality exposure therapy tested which expectancies showed greatest reductions: expectancies about external threat (e.g., 'the spider will bite me', 'people will criticize me') which were not directly testable in a virtual reality environment, or expectancies about internal threat (e.g., 'I will die of fear'), which could be tested and falsified in this context (Scheveneels, Boddez, Van Daele, et al., 2019; Scheveneels & Carpentier, 2025). Following ILR principles, it was hypothesized that testable expectancies (i.e., related to internal threat) would diminish most following exposure. However, the findings in these studies were mixed: internal threat expectations appeared more testable in public speaking anxiety (Scheveneels, Boddez, Van Daele, et al., 2019), whereas external threat expectations appeared more testable in spider fear (Scheveneels & Carpentier, 2025). The questions of which types of expectancies are best testable in which exposure forms and how this relates to symptom change still warrant further investigation.

Finally, the ILR approach to exposure primarily targets fear reduction through extinction learning. However, whether PTSD is best conceptualized as a fear-based disorder has been a matter of debate (Resick & Miller, 2009; Schnyder et al., 2015; Yehuda et al., 2016; Zoellner et al., 2014). Fear plays an important role in PTSD, but it is neither the sole nor necessarily the dominant emotional response involved in its development and maintenance. Emotions such as shame, guilt, and anger are also frequently implicated (McLean & Foa, 2017; Resick & Miller, 2009). By focusing primarily on fear-related expectancies, the ILR approach may overlook clinically relevant processes involving other important emotions. Notably, the original Prolonged Exposure (PE) manual (Foa et al., 2019) includes postexposure processing that explicitly addresses emotions beyond fear, including shame, guilt, and anger.

A broader perspective on ILR principles in clinical practice

Although there are many reviews describing the application of ILR principles in clinical practice (see, for instance: Arch & Abramowitz, 2015; Blakey & Abramowitz, 2016; De Jong et al., 2019; Gropalis et al., 2018; Jacoby & Abramowitz, 2016; Knowles & Olatunji, 2019; Pittig et al., 2016; Tolin, 2019; Weisman & Rodebaugh, 2018), empirical studies testing these principles are still scarce. Since Craske's seminal paper in 2014, several empirical studies have been conducted in non-treatment-seeking individuals with elevated clinical symptoms or specific phobias, recruited from community or university settings, to test whether incorporating ILR strategies into exposure improves treatment outcomes (Blakey et al., 2019; Buchholz et al., 2022; De Jong et al., 2023; Jacoby et al., 2019; Jessup et al., 2025; Johnco et al., 2025; Sauer & Witthöft, 2022; Schyns et al., 2018; Shiban et al., 2015). These studies have used widely varying methods to manipulate different ILR strategies in varying samples. However, none of these studies find evidence that the use of ILR strategies led to improved symptom reduction. See Table 1 for an overview of the studies.

It is striking how few empirical studies testing ILR principles to *improve* treatment outcomes have been conducted in treatment-seeking clinical populations. So far, we have identified only one other study that did so, namely in a sample of youths with an anxiety disorder (Kennedy & Hawks, 2021). In this pilot randomized controlled trial (N = 13), the authors found that ILR-based exposure was effective and feasible. Like us, they encountered methodological challenges, such as delineating ILR exposure from 'standard', EPT-based exposure, and operationalizing 'maximum' violation of expectancies. It is noteworthy that the scarcity of empirical studies in treatment-seeking samples was identified as a critical concern nearly a decade ago (Jacoby & Abramowitz, 2016; Pittig et al., 2016), yet little progress appears to have been made since.

Table 1. Overview of studies manipulating exposure procedures to enhance inhibitory learning since Craske et al., 2014.

Study	Sample	ILR strategy manipulation	Conditions	Outcome	
Blakey et al., 2019	Adults with spider phobia (*N* = 60)	Reduction of safety behaviors	1) Exposure with the elimination of safety behaviors (E/ESB) 2) Exposure with judicious use of safety behaviors (E/JU)	No significant group differences in treatment outcome (fear of spiders and behavioral approach task) or acceptability.	-
Buchholz et al., 2022	Adults with spider phobia (*N* = 45)	Expectancy violation	1) CR before exposure (CR-exp) 2) Exposure before CR (exp-CR) 3) Stress management (CTL)	CR-exp and exp-CR led to greater reductions in spider phobia than CTL, with no differences between the two on fear, avoidance, or cognitions.	-
De Jong et al., 2023	Youths with specific phobia (*N* = 50)	Expectancy violation	1) Exposure conducted in large steps (LSE) 2) Exposure in small steps (SSE)	SSE resulted in less expectancy violation but in a larger decline of specific phobia symptoms compared to LSE.	<
Jacoby et al., 2019	Adults with an obsessional thought (*N* = 40)	Stimulus variability	1) Gradual exposure (EXP-G) 2) Variable exposure (EXP-V)	There were no significant differences in pre to post changes in OCD symptoms between EXP-G and EXP-V.	-
Jessup et al., 2025	Community adults with snake phobia (*N* = 134)	Context and stimulus variability	1) Exposure in multiple contexts (MC) 2) Exposure to multiple stimuli (MS) 3) Exposure to multiple C and S (MCS)	MC resulted in lower threat expectancy than MS and MCS. No effects on symptoms were reported.	<

Table 1. Overview of studies manipulating exposure procedures to enhance inhibitory learning since Craske et al., 2014. *Continued.*

Study	Sample	ILR strategy manipulation	Conditions	Outcome	
Johnco et al., 2025	Adults with elevated public speaking anxiety (*N* = 249)	Expectancy violation	1) Behavioral experiments based exposure (BE) 2) CR before exposure (CR-exp) 3) Exposure without processing of expectancies (CTL)	BE and CR-exp reduced anxiety more than CTL; BE led to more expectancy change. More expectancy change was associated with more anxiety reduction	-/>
Sauer & Witthöft, 2022	Adults with heightened health anxiety (*N* = 54)	Multiple strategies	1) ILR based exposure (ILR) 2) Habituation based exp (HA)	There were no significant differences in pre- to post changes on health anxiety between conditions.	-
Schyns et al., 2018	Obese females (*N* = 52)	Expectancy violation	1) Exposure aimed at habituation (HA) 2) Aimed at expectancy violation (EV) 3) No exposure control (CTL)	There were no significant differences between HA and EV on eating the exposed foods.	-
Shiban et al., 2015	Adults with spider phobia (*N* = 58)	Context and stimulus variability	1) Single stimulus and context (SSSC) 2) Multiple stimulus single context (MSSC) 3) Single stimulus multiple context (SSMC) 4) Multiple stimulus and context (MSMC)	Multiple stimulus but not multiple context exposure led to less return of fear at follow-up test.	-/>

Note. CR = cognitive restructuring; ILR = Inhibitory learning and retrieval; < = significant in favor of non-ILR (control) condition; - = non-significant finding; > = significant finding in favor of ILR condition.

Identifying and targeting mechanisms is difficult

The scarcity of empirical studies testing ILR-enhanced exposure may reflect a gap in the field, but it may also indicate the inherent difficulty of conducting mechanism research. Research aimed at optimizing exposure by actively targeting its mechanisms of change poses several challenges.

First, there is a lack of conceptual clarity in mechanism research (Benito et al., 2024; Cohen et al., 2023). For instance, studies fail to clearly distinguish between active elements (i.e., treatment procedures), proposed mechanisms, and outcomes. These are related, but distinct, concepts: therapeutic elements activate mechanisms which subsequently drive therapeutic outcomes. In the studies included in this dissertation, we aimed to clearly describe and distinguish these processes to gain a more precise understanding of how exposure brings about change. In **Chapter 2**, we controlled for potential conceptual overlap between the mechanism (posttraumatic cognitions) and the outcome (PTSD symptoms) by conducting sensitivity analyses that excluded symptom items reflecting negative cognitions. In **Chapter 4**, we explicitly separated the therapeutic procedure (exposure with a focus on expectancy violation) from the proposed mechanism of change (expectancy change). Despite these efforts, conceptual ambiguity remains, in part due to theoretical overlap. Theories, such as EPT and ILR, often overlap or emphasize different parts of the same process (e.g., distress reduction also violates the expectancy that fear will never subside). This makes it difficult to identify and disentangle mechanisms, and to summarize findings across studies.

Second, mechanism research is challenging due to measurement issues (Benito et al., 2024). Instruments to assess change mechanisms, such as expectancy violation, often lack psychometric validation and empirical studies use different measures or definitions for similar constructs. We have tried to further the field in regard of measurement by providing and testing alternative operationalizations of distress variability (**Chapter 3**), using a combination of objective and subjective measures for fear reduction (**Chapter 4**), and by introducing a new measure that can be used to assess threat appraisal in PTSD (**Chapter 6**). Even so, operational challenges remain. A fundamental issue may lie in the lack of clear operationalization of expectancy violation. There is no standard for how expectancy violation should be defined or measured, and the ILR approach lacks specificity in this regard (see also: Stemerding et al., 2023). Empirical studies have used divergent approaches, such as comparing exposure with and without cognitive restructuring (based on the assumption that restructuring reduces expectancy violation; Buchholz et al., 2022; Johnco et al., 2025), emphasizing expectancies and their non-occurrence (**Chapter 4**), or focusing on the degree to which expectancies are testable (Scheveneels, Boddez, Van Daele,

et al., 2019). A more unified and precise understanding of what constitutes optimal expectancy violation is needed.

Third, individual and contextual differences may affect mechanisms. We often think of mechanisms as competing with one another, but it is likely that multiple mechanisms are simultaneously at play in each individual, interacting in complex ways to produce treatment effects (Benito et al., 2024; Knowles & Tolin, 2022; Scheveneels et al., 2024). For instance, several studies have shown that both expectancy change and distress reduction (i.e., habituation) contribute to symptom improvement (De Jong et al., 2024; Elsner et al., 2022; Scheveneels & Carpentier, 2025). In our studies, although we aimed for precision in measuring individual mechanisms, a limitation is that we did not examine multiple mechanisms concurrently. Additionally, mechanisms may differ across individuals, what works for one person may not work for another (Cooper, Clifton, et al., 2017). Context (e.g., setting, therapist behavior, etc.) also plays a role. For instance, clinicians often tailor exposure procedures to the individual patient (e.g., more gradual exposure when a patient disengages during exposure), a flexibility that is difficult to capture in standardized research designs.

Finally, demonstrating the added value of targeting specific mechanisms is challenging, in part because exposure therapy is already highly effective. Even when a mechanism has been clearly identified and targeted, the added clinical benefit may be small and difficult to detect. Null results do not necessarily indicate that the effect is absent. This issue has also emerged in other enhancement approaches, such as pharmacological augmentation, where null findings are common (McLean & Foa, 2024; Metcalf et al., 2020). Moreover, full-package interventions can introduce considerable noise, making it hard to isolate the impact of individual components and mechanisms. In our work, we have attempted to address this issue using more targeted designs, such as a one-session experimental design (**Chapter 4**) and single-case experimental designs (**Chapter 5**).

Tracking versus manipulating

While the extent to which ILR principles *optimize* exposure outcomes is questioned in this dissertation, this is not to suggest that they are inconsequential within the context of exposure therapy. Although there is a lack of studies in clinical samples investigating the added benefit of these specific exposure strategies, multiple treatment studies have established a (temporal) link between expectancy change and symptom improvement, in a variety of clinical samples, including patients with OCD and anxiety disorders (De Jong et al., 2024; Elsner et al., 2022; Pittig et al., 2022). More specifically, these studies found that more expectancy change was related to more symptom improvement. In non-clinical samples, expectancy change during

exposure has also been linked to subsequent symptom improvement (Johnco et al., 2025; Scheveneels & Carpentier, 2025). We have also found that more general posttraumatic cognitions drive symptom improvement in PTSD during PE (**Chapter 2**), which is in line with reviews on mechanisms of PTSD treatment (Alpert, Shotwell Tabke, et al., 2023; Cooper, Clifton, et al., 2017). How changes in expectancies relate to these more general posttraumatic cognitions requires further investigation. It has been suggested that repeated expectancy violations may subsequently lead to changes in posttraumatic cognitions (Knowles & Tolin, 2022). For instance, repeatedly experiencing that you will not be attacked when going out in the dark may change the more general belief that the world is a dangerous place. We found that concerns about specific outcomes (expectancies) moderately correlated with more general posttraumatic cognitions (measured with the PTCI), suggesting that they indeed capture related but unique aspects of trauma-related cognitions (**Chapter 6**).

Cognitive change, including general posttraumatic cognitions and specific expectancies, is important for symptom reduction. This is evident both in treatments that do not explicitly target cognitions, such as PE, and in those that do, such as Cognitive Processing Therapy (CPT, Asmundson et al., 2019; Holliday et al., 2018). Interestingly, CPT does not seem to be associated with greater (general) cognitive change than PE (Brown, Belli, et al., 2019), even though cognitions are targeted more directly. Furthermore, adding cognitive restructuring to PE (PE+CR) has not led to greater cognitive change or PTSD symptom reduction compared to PE only (Foa et al., 2005; Foa & Rauch, 2004; McLean & Foa, 2024). Thus, even though cognitive change appears to drive symptom improvement, explicitly targeting cognitions has not been shown to improve treatment effects. This may be because different therapeutic procedures engage similar mechanisms through direct or downstream pathways, or because promoting one procedure may positively affect some mechanisms but negatively affect others. For instance, cognitive restructuring may promote cognitive change, but at the same time may diminish threat expectancies before exposure, leaving less room for expectancy violation to occur. Although cognitive change seems an important change process during treatment, there is limited understanding of how to effectively promote it through targeted therapeutic procedures. This question extends beyond exposure therapy for PTSD. In mechanism research on cognitive therapy for depression, it also remains unclear whether cognitive change results directly from procedures designed to target it, as cognitive change has also been observed following interventions that do not explicitly aim to produce it (Lorenzo-Luaces et al., 2015). Nonetheless, tracking cognitive change throughout treatment can provide earlier insight into treatment effectiveness and help tailor interventions, for example by discussing an individual's strongly held cognitions.

Future research agenda

Despite the clear challenges of conducting mechanism research, this type of research remains essential for advancing theoretical frameworks that guide clinical decision-making. Importantly, mechanism research should not only clarify which procedures are effective, but also address other clinically relevant outcomes, such as willingness to engage in exposure and treatment dropout. This interplay is clearly illustrated in the literature on safety behavior. While safety behaviors were initially viewed as counterproductive, which is also posited by the ILR approach, this view has been increasingly challenged by empirical findings (Blakey & Abramowitz, 2016). Some empirical findings suggest that, when used judiciously, safety behavior may enhance the acceptability and tolerability of exposure, and promote approach behavior, self-efficacy, and even inhibitory learning (Blakey & Abramowitz, 2016). This line of research thus helps guide a more nuanced and evidence-informed use of safety behavior in clinical practice. More work is needed, including on other strategies such as expectancy violation, as it is conceivable that exposure sessions in which the patient first tests their most feared outcome could have detrimental effects on willingness to engage or increase the risk of dropout.

The ILR approach to exposure has achieved broad dissemination and is now widely implemented in clinical settings. Its influence is evident in the high citation counts of Craske et al.'s review articles on the clinical application of ILR: 1,047 (2008), 1,392 (2014), and 108 (2022). However, there is still uncertainty about the extent to which ILR strategies should be applied and under what conditions they are most likely to enhance treatment outcomes. While this type of research is methodologically challenging, it remains essential for advancing exposure therapy's theoretical frameworks that inform clinical decision-making. There is a need for consensus on how inhibitory learning strategies should be compared and tested. At present, the variability in methods makes it difficult to synthesize findings or draw conclusions, for example, through meta-analytic approaches. A crucial first step is to establish clear operationalizations of core constructs (such as expectancy violation), supported by validated measurement instruments.

In addition, future (mechanism) research may look into the extent to which active elements of therapy are received by patients (i.e., what the patient understands from the therapist during the session) and applied (i.e., the patient's active implementation of the active elements in daily situations outside the therapy context), as outlined in the framework introduced by Cohen et al., 2023. To date, mechanism research, including our own, has primarily focused on the delivery of specific active elements by the therapist, presumed to activate underlying change processes. However, little attention has been paid to whether these strategies actually reach the patient in a meaningful way. To address this, it is essential to assess, both within and outside

the session, whether patients understand and implement the rationale behind the active elements. With the increasing use of ecological momentary assessment (EMA), also in patient samples (Wrzus & Neubauer, 2023), studies involving such repeated assessments during and between sessions are becoming more feasible.

Clinical implications and recommendations

The ILR approach to exposure has already been implemented in clinical practice. In training settings, there is often strong emphasis on ILR as the correct way to deliver exposure therapy. However, evidence for the clinical superiority of ILR-based exposure over traditional approaches, such as EPT-based exposure, is still lacking. There is currently also no evidence that indicates that ILR-based exposure leads to poorer outcomes. It is therefore one possible way of delivering exposure, but not the only way.

Exposure therapy operates through multiple pathways, some at different or parallel levels, including expectancy violation and change, distress reduction (i.e., habituation), cognitive shifts such as US devaluation, increased self-efficacy, and behavioral activation (Cooper, Clifton, et al., 2017; Scheveneels et al., 2024; Vervliet et al., 2024). It is likely that different exposure exercises engage different processes. For example, the in vivo exercise to repeatedly visit the same local park may no longer elicit strong expectancy violation, but could still promote habituation or behavioral activation. It is important that therapists are aware of the various mechanisms through which exposure can exert its effects, as well as of the different therapeutic procedures and strategies that may activate these mechanisms. This awareness enables therapists to flexibly draw on a range of techniques to facilitate therapeutic change. The ILR strategies are a valuable addition to the exposure therapist's toolkit, but this toolkit may become rather empty if these strategies are treated as the only valid tools.

Exposure therapy for PTSD is effective, this cannot be emphasized enough. At the same time, it remains underused in clinical practice. A recent study from the Netherlands found that two out of three patients with probable PTSD did not receive first-line treatments, including exposure therapy (Hoeboer et al., 2025). Therapist-related factors play a role in this underutilization (Langthorne et al., 2023). Mechanism research has the potential to positively influence the use of exposure therapy in at least two ways: it can help refine treatments or protocols by identifying which elements to in- or exclude, and it can provide therapists with concrete guidance on how to implement interventions. The latter helps therapists build competence and confidence, allowing them to deliver more targeted treatment and make informed decisions during treatment. However, one potential drawback is that such research may inadvertently be interpreted in overly rigid ways, creating

confusion about what is or is not 'allowed' during sessions. This could raise the threshold for using exposure, even when clearly indicated. Rather than policing *how* exposure *should* be delivered, we may lower the threshold for using exposure therapy by encouraging *that* it *is* delivered.

Conclusion

The primary objective of this dissertation was to identify potential avenues for enhancing the efficacy of exposure therapy for PTSD through inhibitory learning and retrieval processes. The ILR approach engendered great expectations, as it promised to optimize exposure therapy. However, we did not find evidence that ILR principles are associated with better treatment outcomes for patients with PTSD. The promise of optimization has not yet been fulfilled, but this does not mean that ILR principles are unimportant. Cognitive change, including expectancy change, has emerged as an important predictor of treatment outcome. However, facilitating these processes through therapeutic procedures remains elusive. A shift in how exposure therapy for PTSD is delivered, based solely on ILR principles, does not seem warranted. Nonetheless, ILR offers a valuable addition to existing approaches.