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Review

Exposure therapy augmentation: A review and extension of techniques informed by an inhibitory learning approach

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HIGHLIGHTS

- An inhibitory learning approach to exposure has begun to garner empirical support.
- This framework generates predictions regarding factors that may enhance exposure.
- Proposed exposure augmentation techniques following from this theory are reviewed.
- Further strategies to enhance exposure therapy and future directions are discussed.

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ABSTRACT

Although exposure therapy is often considered a gold standard behavioral intervention for pathological anxiety, questions remain surrounding the mechanisms underlying exposure interventions, and some individuals are characterized by suboptimal treatment outcomes. Recently, a formulation known as the inhibitory learning theory, which is grounded in basic science principles of extinction learning and memory, has been proposed to provide a more parsimonious mechanistic explanation for the effects of exposure than previous, habituation-based models [Craske, M.G., Kircanski, K., Zelikowsky, M., Mystkowski, J., Chowdhury, N., & Baker, A. 2008. Optimizing inhibitory learning during exposure therapy. *Behaviour Research and Therapy*, *46*, 5–27; Craske, M.G., Treanor, M., Conway, C.C., Zbozinek, T., & Vervliet, B. 2014. Maximizing exposure therapy: An inhibitory learning approach. *Behaviour Research and Therapy*, *58*, 10–23]. Strategies informed by this theory are proposed to maximize extinction learning by fostering the development of new, non-threat associations between stimuli in memory and enhancing the accessibility and retrieval of these safety-based associations. This comprehensive review serves as a critical examination of the empirical literature regarding major tenets of inhibitory learning theory and the potential for such techniques to augment exposure therapy for anxiety disorders. Limitations of the extant research, as well as potential future directions, are explored.

The therapeutic intervention *exposure* is a key component of cognitive behavioral therapy (CBT) for anxiety. Exposure is considered the clinical analog of extinction learning (e.g., Moscovitch, Antony, & Swinson, 2009, among others), in which repeated presentations of a specific fear-eliciting object or situation (i.e., conditioned stimulus; CS) in the absence of the aversive consequence with which it was previously paired (i.e., unconditioned stimulus; US) extinguishes conditioned fear responses. Although several meta-analyses have supported the efficacy of CBT that includes exposure (e.g., Olatunji, Cisler, & Deacon, 2010), the mechanisms underlying exposure are not well-understood (e.g., Moscovitch et al., 2009). Further, many individuals fail to achieve clinically-significant symptom relief (Arch & Craske, 2009) and relapse is common in the long term (see Vervliet, Craske, & Hermans, 2013 for a review). Factors that enhance exposure stand to make a meaningful clinical impact.

The prevailing model for exposure in the empirical literature has been emotional processing theory (EPT; Foa, Huppert, & Cahill, 2006; Foa & Kozak, 1986). EPT, at least as originally formulated (although, importantly, not in its more recent iterations; cf. Foa et al., 2006) proposes that emotional processing involves *replacement* of pathological associations among stimuli, responses, and meaning. The original formulation of EPT, however, is inconsistent with research suggesting that extinction results in new learning that competes with old information (e.g., Bouton, 2000; Rescorla, 2001), as well as studies demonstrating that retention of at least part of an original fear association can be uncovered by various means (e.g., passage of time; Quirk, 2002).

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Recently, a conceptualization proposed to maximize the efficacy of exposure has garnered empirical support. This formulation, known as the inhibitory learning theory (Craske et al., 2008; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014) not only provides a potential explanation of exposure's effects, but also produces predictions as to what factors might enhance the effects of exposure. According to this theory, following successful exposure, the stimulus possesses both the original excitatory (i.e., fear-based, CS-US) meaning as well as an inhibitory (i.e., safety-based, CS-no US) meaning. In other words, extinction learning modifies memory structures that underlie emotions, such that new, safety-based associations between previously-feared stimuli *inhibit* previous, danger-based associations. Accordingly, even if fear subsides following successful exposure, the original excitatory meaning is retained and may be recovered; such recovery is broadly described as *renewal*. *Re*-emergence of a previously-extinguished CR after a delay, known as *spontaneous recovery*, or following re-exposure to an aversive stimulus, known as *reinstatement*, are specific examples of renewal.

Craske and colleagues (Craske et al., 2008; Craske et al., 2014) suggest a shift away from habituation-based models that construe level of fear throughout exposure as an index of corrective learning. Craske et al. assert that such models are inconsistent with advances in the basic science of extinction learning and memory (e.g., Bjork & Bjork, 2006). Instead, they theorize that an approach aimed at maximizing inhibitory learning through (a) developing new, non-threat associations and (b) enhancing the accessibility and retrieval of newly-learned associations will enhance the efficacy of exposure. Further, Craske et al. (2014) recommend a deemphasis on proposed indicators of emotional processing (e.g., within-session habituation; WSH), in light of mounting evidence that these indices may not be prognostic in terms of long-term outcome from extinction or exposure (Asnaani, McLean, & Foa, 2016). Notably, recent updates to Foa and Kozak's original (1986) theory have deemphasized WSH as a prognostic indicator of outcome, instead converging with Craske and colleagues on the notion that previous *and* new information remains stored in memory, with modification of relevant pathological associations through disconfirmation producing positive treatment response (Foa et al., 2006).

Several specific techniques have been suggested by Craske et al. to function in service of establishing new, nonpathological associations in memory and increasing the likelihood of successful retrieval. Thus far, these predictions have only been reviewed relatively briefly and by the originators of the formulation itself. Principles of scientific rigor suggest that it would be ideal for the theory and its supporting literature to undergo independent evaluation and investigation. We therefore set out to review this literature in more depth, independent of the originators of the theory. In our review, we critically examine the extant literature pertaining to Craske and colleagues' (Craske et al., 2008; Craske et al., 2014) proposed exposure augmentation techniques for treatment of the DSM-IV-TR (American Psychiatric Association, 2000) anxiety disorders: specific phobias, generalized anxiety disorder (GAD), panic disorder, social anxiety disorder (SAD), obsessive compulsive disorder (OCD), and posttraumatic stress disorder (PTSD). Although the latter two disorders are no longer considered anxiety disorders according to DSM-5, they are included due to an extensive body of literature examining exposure therapy in these populations (albeit with fewer investigations of augmentation regarding PTSD).

We have retained the general organizational structure of the inhibitory learning theory as described by Craske et al., 2008 and Craske et al., 2014 to guide our discussion, with novel additions where relevant. We also wish to note that, in accordance with the recommendations of Maxwell and Cole (2007), we only describe studies involving *both* temporal precedence and previous assessments of outcome measures as tests of mediation. A final note is that although the extent to which these principles apply to all anxiety-related conditions is technically unknown, inhibitory learning theory makes no distinction between disorders, and generally what is true of exposure for anxiety disorders is expected to be true of, for example, OCD.

1. Strategies to develop non-threat associations

1.1. Maximizing mismatches with expectancies

It has long been proposed that the discrepancy between expectancy and outcome is a critical component of extinction learning (Rescorla & Wagner, 1972). Thus, if an individual has particular expectations regarding how often aversive events should occur in terms of duration or frequency, then exposures that clearly violate these expectancies should provide the strongest mismatches (Craske et al., 2008). Unfortunately, no studies of exposure have examined these issues in detail (e.g., by assessing expectancies about duration or frequency of aversive events). However, two recent studies have investigated how the *magnitude* of expectancy violation impacts the efficacy of exposure. In the first, Baker et al. (2010) examined the relationship between expectancy of negative events and treatment outcomes in undergraduates with heightened acrophobic fears. Baker et al. found that as long as exposures were of ample duration to optimize expectancy violation, the length of each session did not significantly impact treatment outcome; in fact, the expectancy violation approach, which entailed just one exposure trial per 2 days, resulted in similar long-term benefit at follow-up relative to repeated trials of exposure each day (Baker et al., 2010).

A second study by Deacon et al. (2013) compared interoceptive exposure that continued until the participant's expectancy of an aversive outcome reached less than 5% (intensive IE) to standard interoceptive exposure (low-dose IE) in individuals with elevated anxiety sensitivity. As hypothesized, Deacon and colleagues found that intensive IE produced significantly greater reductions in anxiety sensitivity and fearful responding to a straw-breathing task, though notably the authors did not appear to control for time. Collectively, these two studies provide initial evidence that expectancy violation may indeed serve as a key target for intervention to maximize extinction learning. This pair of studies is particularly compelling because both entailed a direct, theory-driven test of the impact of expectancies on treatment outcomes. Therefore, although these findings need to be replicated in clinical populations, maximizing expectancy violation is among the most promising strategies to increase the efficacy of exposure.

1.1.1. Limiting distraction

In contrast, distraction is theorized to impede learning by reducing awareness of the CS as well as the relationship between the CS and nonoccurrence of the US (Craske et al., 2014). In other words, distraction should limit the ability to either create a mismatch or highlight it if it occurs. An extensive body of work examining distraction during exposure has been inconsistent. The range of conclusions regarding the effects of distraction ranges from malignant (e.g., Dethier, Bruneau, & Philippot., 2015; Kamphuis & Telch, 2000; Mohlman and Zinbarg, 2001), to benign (e.g., Antony, McCabe, Leeuw, Sano, & Swinson, 2001; Telch et al., 2004), and even to facilitative (e.g., Johnstone & Page, 2004; Oliver & Page, 2008; Penfold & Page, 1999). However, the studies finding enhancement via distraction are characterized by substantial limitations, including a lack of manipulation checks or exposure-only group (e.g., Johnstone & Page, 2004), the use of nonclinical samples coupled with a failure to replicate the effects in diagnosed samples, and an inability to maintain effects when the distractor is no longer present (Penfold & Page, 1999). Collectively, these methodological shortcomings and failures to replicate cast doubt on arguments made in favor of distraction.

A meta-analysis by Podină, Koster, Philippot, Dethier, and David (2013) aimed to reconcile these disparate findings exclusively in specific phobia populations. Podină et al. found no significant difference between the efficacy of distracted (versus focused or uninstructed) exposure in terms of self-reported distress or physiological indices at post-exposure or follow-up. However, the behavioral results (e.g., number of steps completed during a behavioral approach test) were quite disparate. Notably, a moderation analysis revealed that distracted exposure significantly outperformed focused exposure when the distractor was interactive (i.e., involved communication with the therapist).

Taken together, the empirical literature fails to provide a clear consensus regarding the impact of distraction on exposure efficacy. Further clouding interpretation of these studies is what seems to be a basic disagreement about what constitutes a distraction (e.g., relatively pure high cognitive load versus presence of a person to interact with), how to tell if people are distracted (e.g., can people self-report distraction reliably?), and what outcome should be measured (e.g., physiological responding versus self-report). This literature could clearly benefit from a focus on the mechanism(s) underlying distraction effects, consistent paradigms, and a standard set of outcome variables. More specifically, we agree with previous authors who suggest that there is a difference between distracted attention and *diminished* attention (e.g., in terms of cognitive load; Foa et al., 2006). For example, one could imagine a client being distracted during an exposure by chatting with a therapist and yet not missing any disconfirming information, whereas other forms of distraction might more meaningfully diminish attention.

A final important consideration involves the potential for distractors to function as safety behaviors, or actions designed to avert or cope with a perceived threat (i.e., the CS during exposure; Salkovskis, Clark, & Gelder, 1996); that is, clients may rely on distraction as a means of avoiding engagement with feared stimuli. Given the potential for safety behaviors to be deleterious in terms of diversion of attentional resources and misattribution of safety (detailed further below), coupled with a paucity of methodologically-sound empirical support for selective use of either distraction or safety behaviors, it is recommended that clinicians consider limiting distractors as much as possible. However, it must be said that the existing literature is far less conclusive about distraction than would be expected given inhibitory learning theory. In particular, there is no evidence to be found that minor discussion with a therapist during exposure would have any deleterious effects; in fact an argument can be made that informal chit-chat during exposures could constitute a fear antagonistic action, a concept we discuss next.

1.1.2. Fear antagonistic actions

An additional exposure augmentation strategy, not proposed by Craske and colleagues, involves the use of fear antagonistic actions (FAAs; Wolitzky & Telch, 2009). These are actions, such as encouraging acrophobic patients to run toward the rail of a balcony, that are in direct opposition to the fear action tendencies associated with anxiety, potentially maximizing mismatches. According to proponents of the FAA formulation, oppositional actions enhance fear reduction by making threat-disconfirming information more available during exposure, even though this will also lead to increased fear activation effects in the short-term. Further, FAAs are proposed to result, usefully, in the inadvertent elimination of safety behaviors (see the Elimination of Safety Behaviors section, below).

In a randomized controlled trial (RCT) aimed to test this theory by Wolitzky and Telch (2009), an exposure plus oppositional actions group showed significantly greater improvement on behavioral and questionnaire measures at posttreatment and follow-up relative to exposure alone. Further, the superior efficacy of this condition generalized to a novel context. In a second study by Nelson, Deacon, Lickel, and Sy (2010), undergraduates with high public speaking anxiety were randomly assigned to single-session interventions aimed at reducing either (a) the perceived probability or (b) the perceived cost of negative outcomes. Participants in the cost condition were instructed to engage in potentially embarrassing behaviors throughout each speech trial (e.g., stuttering, mumbling), to enhance learning that the consequences of such actions would not be as intolerable as they imagined. Consistent with the FAA framework, the cost group demonstrated significantly greater improvement on measures of public speaking anxiety and cost estimates for negative social events (Nelson et al., 2010).

The above results are for brief interventions and relatively mildly impaired participants, which leads us to be circumspect in interpretation. Nevertheless, this technique is encouraging because it represents another pathway through which expectancies can be explicitly leveraged to optimize the development of safety-based associations in memory. Anecdotally, we have noted that FAA is intuitively appealing to clinicians whether they are aware of the FAA literature or not. For example, it is common practice in SAD treatment to engage in intentional mistake practice (e.g., wearing one's shirt inside out; Hofmann & Otto, 2008) in addition to more traditional exposures such as engaging in conversations with strangers. If the results of the preceding studies are replicated with clinical populations, we are optimistic that the adaptation of FAA to treatment of other disorders will become equally ubiquitous.

1.1.3. Cognitive approaches

A final technique consistent with the notion of expectancy violation is the addition of cognitive interventions. Craske et al. (2008) briefly state that cognitive approaches capitalize on mismatches with expectancies for aversive events through logical empiricism, consistent with the goal of developing non-threat associations. However, Craske et al. (2014) note that cognitive interventions designed to decrease probability overestimation and perceived negative valence may impede inhibitory learning when used prior to or during exposure because they may change expectancies and reduce mismatch. Conflict regarding the overall role of cognitive changes in exposure therapy has a long history that we do not have the space to recount here. Suffice it to say that, consistent with the lack of consensus among researchers, the empirical literature has provided an inconsistent picture regarding whether adding cognitive techniques has significant facilitative effects.

In reviewing the efficacy of assorted CBT components across the DSM-IV-TR anxiety disorders, Deacon and Abramowitz (2004) noted that the meta-analytic literature is often insufficient for determining the relative effectiveness of cognitive versus behavioral interventions due to a paucity of studies testing strictly cognitive interventions as well as varying classifications for the same procedures across studies. Notably, a relatively new technique known as network meta-analysis (Dias, Sutton, Ades, & Welton, 2013) holds promise for testing relative effects indirectly (i.e., even in the absence of comparisons between specific conditions). In a meta-analysis of CBT treatment outcome across the anxiety disorders, Norton and Price (2007) did not observe any differences in effect sizes across any combination of components, including exposure plus cognitive therapy versus exposure alone. In the most recent systematic review to date (though PTSD was excluded), McMillan and Lee (2010) found what they described as tentative evidence that framing exposure as a cognitive test may be more effective than exposure in which this does not occur. However, results were not fully consistent, and the group of studies suffered from methodological limitations including potential therapist allegiance effects (McMillan & Lee, 2010).

This lack of consistent effects across the empirical literature may reflect the multitude of theoretical issues involved in examining the potential augmentative role of cognitive techniques on exposure. The most substantial of these is that it is arguably impossible to ensure that all conditions are mutually exclusive. For example, there is no way to know for certain what type of cognitive processes participants in an exposure-only condition are engaging in. Thus, it has been proposed that behavioral and cognitive interventions can potentially be considered interrelated techniques designed to promote the experience of what a situation is really like (Rodebaugh, Holaway, & Heimberg, 2004), which is consistent with the expectancy violation tenet of the inhibitory learning theory. However, those authors (and, indeed, most authors of past articles on the topic) have not focused on the merits of timing cognitive interventions before versus after exposure. Strategic timing of cognitive interventions to reduce the likelihood of unintentionally minimizing expectancy violation may serve to optimize their efficacy as exposure augmentation tools (Craske et al., 2008), but this possibility clearly requires direct tests.

1.2. Deepened extinction

A second method aimed at developing new, non-threat associations to feared stimuli is described by Craske and colleagues (Craske et al., 2008; Craske et al., 2014) as compound or *deepened* extinction. This term refers to when (a) two or more fear-provoking stimuli are extinguished separately before being combined for additional trials or (b) a previously-extinguished cue is paired with a new CS. The theory underlying deepened extinction states that the absence of an aversive stimulus in the presence of multiple (i.e., as compared to single) predictors of the stimulus will lead to greater inhibitory learning. In either case, it is integral that both cues predict the same US. For example, for an individual with blood-injection-injury phobia, a hypodermic needle and tourniquet are two different cues associated with blood (i.e., the US). Craske et al. (2014) describe several examples of this technique, including interoceptive exposure coupled with exposure to feared agoraphobic situations for individuals with panic disorder (e.g., drinking caffeine while walking through a crowded mall) and exposure to one spider, followed by a second distinctly different spider, followed by exposure to both spiders at the same time, for a phobic patient.

Turning to research support, the first two laboratory studies conducted in humans using nonclinical paradigms (Lovibond, Davis, & O'Flaherty, 2000; Vervliet, Vansteenwegen, Hermans, & Eelen, 2007) failed to show deepened extinction effects. In contrast, a recent study provided preliminary evidence that inducing elemental processing of compound stimuli may enhance the efficacy of deepened extinction. Culver, Vervliet, and Craske (2015) found that despite elevated fear responding during extinction, undergraduate participants who underwent compound trials demonstrated significantly less fear responding at spontaneous recovery and reinstatement test than participants who underwent single extinction trials. At reinstatement test, only compound presentation predicted less fear responding.

In sum, although there is a strong theoretical rationale for the use of deepened extinction as a technique to enhance the efficacy of exposure, evidence is limited at present. It also remains to be seen whether this technique can be translated effectively to clinical practice. In addition to conceptual issues surrounding the format of extinction (i.e., simultaneous versus sequential), it also remains unclear if compound exposure is effective when the two conditioned stimuli do not predict the same aversive outcome. Therefore, it is premature to recommend that this intervention be integrated into the routine practice of exposure therapy.

1.3. Elimination of safety behaviors

Safety behaviors can be overt or covert and often entail avoidance of situations (e.g., elevators for an individual with claustrophobia) or cognitions (e.g., mental distraction techniques). They can also be quite subtle and disorder-specific, such as always carrying a bottle of water or a cellular phone for panic disorder patients (Kamphuis & Telch, 1998). Several mechanisms have been proposed to explain the deleterious effects of such behaviors on anxiety symptoms, including a misattribution of safety to the safety behavior or signal (Salkovskis, 1991), diversion of attentional resources away from disconfirming information, and unintentional transmission of threat information due to activation of alarm mechanisms (i.e., sensorimotor signals transmitted to the amygdala) in the absence of cognitive appraisal (Sloan & Telch, 2002). Conversely, proponents of the judicious or temporary use of safety behaviors (e.g., Deacon, Sy, Lickel, & Nelson, 2010; Rachman, Radomsky, & Shafran, 2008) purport that there are several potential advantages, including increased acceptability and tolerability of exposure, facilitated approach behavior, and an enhanced sense of control and self-efficacy for clients.

An extensive empirical literature has demonstrated that safety behaviors predict poorer long-term outcomes compared to exposure alone in samples spanning the DSM-IV anxiety disorders (Helbig-Lang & Petermann, 2010). Further, it has been proposed that the distraction literature may also serve as evidence for the pernicious effects of safety behaviors (e.g., Sloan & Telch, 2002), although there are reasons (reviewed above) to temper the conclusion that distraction definitely impedes exposure. In their analysis of safety behaviors from an inhibitory learning perspective, Blakey and Abramowitz (2016) reviewed potential mechanisms through which safety behaviors may interfere with or enhance exposure. Regarding the theory that safety behaviors may have facilitative effects and thus should be integrated selectively into exposures (i.e., so-called judicious use of safety behaviors), the authors concluded that the impact of this approach on inhibitory learning mechanisms cannot be determined at present due to a lack of experimental investigation. Nevertheless, they asserted that the tendency for interference with exposure outcomes coupled with insufficient empirical support for judicious use leads them to recommend elimination as soon as clients are willing (Blakey & Abramowitz, 2016).

Similarly, a recent meta-analytic review by Meulders, Van Daele, Volders, and Vlaeyen (2016) failed to provide compelling evidence supporting either the removal or addition of safety behaviors during exposure. However, though not statistically significant, average effect sizes were in favor of exposure without safety-seeking behavior. Meulders and colleagues identified several contributors to the inconclusive findings (e.g., variability in the conceptualization of safety behaviors, individual differences in the function of particular behaviors) as well as shortcomings of the meta-analysis (e.g., a relatively small number of studies overall) that warrant cautious interpretation of their results (2016). Conversely, there is also a budding literature comprised of studies that fail to show detrimental effects of safety behaviors, though direct empirical evidence for facilitative effects of safety behaviors is lacking (e.g., Rachman, Shafran, Radomsky, & Zysk, 2011; van den Hout, Engelhard, Toffolo, & van Uijen, 2011). It is also important to note that many of these studies have been marked by considerable limitations, including a lack of control group, the use of samples likely characterized by low reliance on safety behaviors in daily life (e.g., undiagnosed participants), and behavioral approach test ceiling effects. Further, the majority of studies in support of judicious use of safety behaviors have used specific phobia samples.

When considering these conflicting findings regarding the impact of safety behaviors on exposure therapy outcomes, it is important to keep in mind several factors. Perhaps most importantly, it is extremely challenging to assess subtle or covert safety behaviors, precluding many authors from obtaining definitive manipulation checks. Anxiety outcomes were also measured at posttreatment (i.e., as opposed to follow-up assessments occurring later) for most studies, which runs counter to the inhibitory learning theory's deemphasis on fear-related performance during exposure as an index of learning. That is, many results described above reflect habituation-based indicators of change such as fear during or immediately following exposure, even though the empirical evidence suggests that these are not actually prognostic (Craske et al., 2008). Finally, there is preliminary evidence pointing to a theoretical distinction between safety aid *availability* and *utilization*, suggesting that it may actually be the perceived availability of safety signals that interferes with learning (Powers, Smits, & Telch, 2004). In sum, although some studies have provided limited evidence that safety behaviors may not be detrimental to exposure efficacy, there is minimal empirical support for the notion that they can have facilitative effects. Therefore, we recommend that treatment providers focus on the reduction of safety behavior availability and utilization, although this recommendation is admittedly in part due to a strong theoretical rationale.

1.4. Use of cognitive enhancers

Craske et al. (2008) theorize that pharmacological methods of cognitive enhancement may also promote development of new, non-threat associations without influencing expression of the conditioned response during extinction. Notably, cognitive enhancers are posited to exert their facilitative effects by enhancing extinction learning as opposed to modifying a particular aspect of the exposure experience.

1.4.1. D-cycloserine (DCS)

Fear extinction has been shown to be dependent on N-Methyl-D-aspartate (NMDA)-type glutamate receptors, such that DCS, a partial NMDA receptor agonist, may facilitate fear extinction and exposure therapy (see Davis, Ressler, Rothbaum, & Richardson, 2006 for a review). However, the growing empirical literature investigating the effects of DCS on exposure therapy has been quite mixed in findings, leading to several meta-analyses that have aimed to reconcile these inconsistencies. Most recently, Mataix-Cols et al. (2017) examined raw data from 21 RCTs across the DSM-IV anxiety disorders and reported that DCS showed greater improvement from pretreatment to post-treatment, but not from pretreatment to midtreatment or from pre-treatment to follow-up. The augmentation effect was small. Further, more recent studies were associated with significantly smaller differences between DCS and placebo for pretreatment to follow-up improvement. Number of treatment sessions, timing and dose of DCS, and all patient-level (e.g., demographics) and study-level (e.g., primary diagnosis) variables tested failed to moderate treatment outcomes. Thus, although some initial work was suggestive of a promising main effect of DCS as a cognitive enhancer, Mataix-Cols and colleagues' findings indicate that enthusiasm for this technique should be tempered. That being said, it remains plausible that significant moderators of the DCS effect may emerge through future research. For example, Mataix-Cols et al. were unable to examine in-session experiences as possible moderators (e.g., end-of-session fear), which precluded replication of previous findings (e.g., Smits et al., 2013).

Several theoretical considerations regarding this literature also merit attention. To begin with, many studies investigating the effects of DCS have yielded good therapy response of the placebo group, which may produce ceiling effects. Moreover, many of the moderators that have been proposed are correlated, demanding large samples and careful interpretation. For example, trials for OCD are often of a longer duration (Bontempo, Panza, & Bloch, 2012), making it difficult to be sure that *duration of trial* as a moderator meant the same thing across disorders in the Mataix-Cols et al. (2017) mega-analysis. We suspect that costly work focusing on trials of DCS in regard to individual differences will be necessary to determine under what conditions, if any, DCS produces maximal increased benefit to at least some individuals.

1.4.2. Exercise interventions

An additional technique not originally proposed by Craske and colleagues that may operate through similar mechanisms involves brief bouts of exercise. Specifically, convergent evidence from both human and non-human animal studies suggests that physical activity facilitates neural plasticity of certain brain structures, thereby improving cognitive functions (Hötting & Röder, 2013). Accordingly, it has been proposed that exercise could augment exposure through cognitive enhancement of extinction learning in a similar manner to DCS (Ströhle et al., 2010). Recently, studies focusing on brief bouts of physical activity have shown that cardiovascular exercise alters specific aspects of delayed long-term memory, with moderate to large effect sizes (Roig, Nordbrandt, Geertsen, & Nielsen, 2013). The results of studies exploring how acute exercise modulates short-and long-term memory pooled together have also yielded a positive, small main effect (Chang, Labban, Gapin, & Etnier, 2012; Lambourne & Tomporowski, 2010).

In the first direct test of the exercise augmentation hypothesis, Powers et al. (2015) found that participants with PTSD who exercised experienced reductions in symptoms as well as elevated BDNF after 12 weeks relative to those in an exposure-alone group. However, a second, as yet unpublished study (Jacquart, 2016) did not show an enhancement effect of acute exercise in a sample of adults with a marked fear of heights. Future examinations of the exercise enhancement hypothesis would benefit greatly from larger samples that extend beyond young, healthy individuals, though we acknowledge that risks associated with exercise in other populations makes this aim inherently challenging. Several incremental steps forward will be required in terms of identifying the optimal experimental design (e.g., regarding type, intensity, length, and timing of exercise) to extend the use of acute exercise interventions to the clinical realm. That being said, further exploration may be particularly worthwhile in light of the relative ease of administration and potential health benefits associated with acute bouts of exercise.

1.5. Occasional reinforced extinction

Another therapeutic strategy for increasing the development of non-threat associations identified by Craske et al. (2014) is known as occasional reinforced extinction, in which an aversive outcome (US) is strategically paired with a particular feared stimulus (CS) during sporadic trials. A clinical application of occasional reinforced extinction is to incorporate social rejections in exposures for SAD, with the exposure situation itself serving as the CS and the rejection serving as the US for select trials. Craske et al. also reference shame attacks as a form of occasional reinforced extinction for SAD; however, this particular usage only makes sense if such attacks involve integrating purposeful negative feedback that would make clients feel ashamed as opposed to the more traditional definition, which is similar to intentional social mishaps (i.e., actions the client *believes* will draw some form of social ridicule or public disapproval, although this typically does not occur; Ellis & Dryden, 1987). Another example of occasional reinforced extinction is the deliberate induction of panic attacks using substances such as yohimbine (Craske et al., 2014).

The benefits of occasional reinforced extinction are proposed to come from an expectancy violation in which the client is less likely to expect the next CS (e.g., a particular feared social situation) to predict the US (e.g., a rejection) because CS-US pairs (e.g., exposures involving feared outcomes) have been associated with both further pairs of this nature as well as CS-no US pairs (e.g., exposures in which no rejections occur; Craske et al., 2014). In other words, following a real-world social rejection, an individual with SAD who experienced occasional rejections across exposure would be less likely to expect all *further* outcomes to be negative relative to someone who did not experience such rejections during treatment. Essentially, occasional reinforced extinction provides evidence that positive outcomes can follow negative outcomes instead of one negative outcome signaling that the future is globally negative.

In terms of research evidence, one non-human animal study (Bouton, Woods, & Pineño, 2004) as well as one study using a standard human conditioning paradigm (Culver et al., 2014) have found that occasional reinforced extinction sustains fear arousal during extinction, but attenuates subsequent reacquisition of fear; these results are intuitive when one adopts the perspective that occasional practice persisting despite the occurrence of feared stimuli should prepare clients to persist in the face of similar difficulties in the future. Given the paucity of studies investigating this technique, it is inappropriate at this time to draw any conclusions regarding its efficacy, although we expect it will be a valuable avenue to pursue.

1.6. Affect labeling

Another way to develop new, non-threat associations to feared stimuli proposed by Craske et al. (2014) is referred to as affect labeling. This method, also known as linguistic processing, involves verbally labeling one's emotional experience during exposure. This strategy represents a behavioral method of enhancing inhibitory regulation via the prefrontal cortex (PFC; Craske et al., 2008). Specifically, the PFC has been proposed to exert inhibitory control over the amygdala during extinction training, resulting in decreased fear responding (see Maren & Quirk, 2004). The hypothesized benefits of affect labeling are grounded in experimental studies showing that verbalization of current emotional experience, irrespective of form (i.e., spoken or written), leads to reduced distress relative to conditions in which no verbalization or verbalization of nonaffective material occurs (Frattaroli, 2006). Further, Lieberman, Inagaki, Tabibnia, and Crockett (2011) found across a set of four studies with undiagnosed participants that affect labeling attenuated subjective emotional response to positive and negative images, relative to simply watching them. Affect labeling led to significantly less distress *and* less pleasure for the relevant images: The technique may generally dampen affective response.

Studies of linguistic processing in clinical populations have generally supported its efficacy as an exposure augmentation technique. Tabibnia, Lieberman, and Craske (2008) investigated skin conductance and heart rate responses to threatening pictures for an unselected sample as well as spider-fearful participants. Consistent with hypothesis, the authors found significant effects for exposure plus unrelated negative labels relative to exposure alone. Two clinical studies by the same research group (Kircanski, Lieberman, & Craske, 2012; Niles, Craske, Lieberman, & Hur, 2015) examining exposure therapy with spider-fearful and public speaking-fearful participants, respectively, showed positive effects of affect labeling in physiological responding, but not self-report measures. Across both studies, greater use of fear and anxiety labels (i.e., in terms of frequency) also predicted better physiological outcomes.

There are several issues to consider with regard to the budding literature on linguistic processing. First, inconsistencies in patterns of physiological responding are well-documented in the anxiety literature, which has cast doubt on whether they should be relied upon as evidence of fear in the absence of additional measures (e.g., Mauss, Levenson, McCarter, Loren, & Gross, 2005). Moreover, it remains plausible that labeling processes that do not involve affective material (e.g., narrating the experience through statements such as "the spider is crawling in the palm of my hand") may also be successful, a hypothesis that has not been extensively tested in the extant literature regarding self-report effects in particular (Lieberman et al., 2011). It is also unclear whether non-self-relevant affect labeling differs from self-relevant affect labeling, which may result in limited generalizability for some studies.

In sum, further study is needed to investigate incongruent findings across modes of assessment as well as the clinical applications of linguistic processing during exposure. Accordingly, healthy skepticism is warranted on the basis of the empirical literature. That being said, we believe that affect labeling holds promise as a means of enhancing functional connectivity between the PFC and the amygdala, thereby enhancing the processing of motivation to avoid feared stimuli and decreasing that motivation. Following this logic, any verbal processing in which the stimuli and emotional tone are acknowledged (i.e., even if the labeling is not explicitly a statement of feeling) might be efficacious. We are optimistic that direct tests of potential mechanistic explanations for effects of affect labeling will greatly advance the literature base bridging traditional clinical psychology and neuroscience.

1.7. Positive mood induction

Another intervention that may foster development of non-threat associations between stimuli, but was not mentioned by Craske and colleagues (Craske et al., 2008; Craske et al., 2014), involves positive mood induction. The application of self-regulation theories (e.g., Carver & Scheier, 1998; Higgins, 1997) to psychological disorders (e.g., Dickson & MacLeod, 2004a, 2004b) provides a theoretical rationale for this technique. Carver and Scheier (1998) describe behavior as goal-driven and motivated primarily by two semi-independent affective systems. The approach system involves positive goals and the increased positive affect related to satisfactory movement toward those goals, whereas the avoidance system focuses on movement away from negative, unpleasant, or unwanted possible outcomes. Carver and Scheier contend that approach goals are uniquely associated with happiness versus sadness, whereas avoidance goals are uniquely associated with anxiety versus calmness (1998). One implication of this formulation is that shifting goals in a specific situation might change affective experience. For instance, shifting to *approaching* as opposed to simply *not-avoiding* during exposure may have important implications for treatment outcomes in terms of both affect and anxiety reduction.

Indirectly supporting this contention, Rodebaugh (2007) reported that speech-anxious participants identified more specific goals related to avoidance as compared to approach during a public speech. However, two follow-up studies by Rodebaugh and Shumaker (2012) offered the counter-intuitive finding that avoidance goals actually showed stronger relationships with positive affect than negative affect, with most participants not reporting avoidance goals. The authors proposed that participants may have been focusing implicitly on the higher-order (avoidance) goal of not giving a bad speech, but explicitly endorsed low-level approach goals they viewed as being in service of that goal (e.g., speaking clearly). These findings highlight the difficulties in determining which goals are actually motivating individuals. In a finding more congruent with the proposals of Carver and Scheier (1998), however, Trew and Alden (2012) found evidence that higher positive affect predicted the presence of fewer avoidance goals. Given that our ability to induce positive mood generally lags behind our ability to reduce negative mood (Westermann, Spies, Stahl, & Hesse, 1996) and there has been limited research directly testing which factors lead to positive affect in anxiety-provoking situations, much work may be required before such interventions represent a viable exposure augmentation strategy.

2. Strategies to enhance retrieval of newly-learned associations

2.1. Increase variability during exposures

The first technique identified by Craske and colleagues (Craske et al., 2008; Craske et al., 2014) to increase retrieval of new, safety-based associations to previously-feared stimuli involves variation in exposure characteristics such as type or number of stimuli, trial duration, and level on the hierarchy (i.e., degree of overall difficulty or intensity). The proposed benefits of this method are derived from memory research showing that variation increases the storage strength of information to be learned (Bjork & Bjork, 1992, 2006). This process occurs through greater availability of cues that were present during prior learning, which in turn facilitates retrieval of the information. Craske et al. (2008) review evidence that variability results in pairing material to be learned with more retrieval cues, thereby leading to enhanced retrieval because the cues associated with new learning are more likely to be present in a situation where retrieval is required (Bjork, 1988). Variation is also purported to lead to superior generalization (Schmidt & Bjork, 1992).

Accordingly, several research studies have been conducted that involve manipulating key aspects of the exposure design. In a study of nonclinical spider phobic participants, Rowe and Craske (1998a) found that participants who were exposed to one spider showed a clear return of fear at 3-week follow-up relative to those who were exposed to four different spiders. Using two samples of undergraduates reporting high fear of heights, Lang and Craske (2000) compared random and variable exposure (i.e., exposure to heights in a random order, in more than one situation, and with different manners of approach) to blocked and constant exposure (i.e., exposure to the same balconies repeatedly before moving up, using the same approach). Essentially, they compared the use of a standard exposure hierarchy to randomly assigning exposures from such a hierarchy. Lang and Craske reported that random and variable exposure resulted in lower self-reported general (i.e., not heights-specific) anxiety 1 month later, but there were no differences in return of fear across conditions, failing to replicate the return of fear findings of Rowe and Craske (1998a). Notably, random and variable exposure also produced higher peak levels of fear during exposure, which might suggest that in clinical practice some clients would reject this approach.

More recently, Kircanski et al. (2012) compared random and variable to blocked and constant exposure conditions with regard to contamination fears and found no significant between-group differences in treatment outcomes. However, the effect sizes on most measures at 2-week follow-up (albeit small) suggested lower levels of subjective fear in the random and variable group. Moreover, greater variability in distress predicted lower subjective fear at follow-up, suggesting that experiencing variable levels of fear may enhance treatment outcomes. In another recent study, spider-phobic participants demonstrated significantly better short- and long-term outcomes from virtual exposure to multiple stimuli (compared to a single stimulus) within a single context (Shiban, Schelhorn, Pauli, & Mühlberger, 2015), replicating the findings of Rowe and Craske (1998a).

Of the above studies, only one used a diagnosed sample (Shiban et al., 2015); further, the studies possessed limitations such as potential ceiling effects (Kircanski et al., 2012) and the use of virtual reality exposure as a sole technique (Shiban et al., 2015), as well as limited physiological findings. Moreover, some authors (e.g., Rowe & Craske, 1998a) have suggested that extant stimulus variability manipulations may not have been maximally potent (e.g., by using solely one spider species), and further, that varying other features such as type of task or context (discussed below) may produce more robust results by integrating multiple forms of variability concurrently. Despite these shortcomings, this body of research suggests a need for considerable changes to the practice of exposure therapy. Empirical evidence indicates that the prevailing model of conducting exposure according to a graduated hierarchy of feared situations can, and potentially should, be abandoned. Given the potential repercussions of slowly progressing through the hierarchy, which range from spending more time to arrive at the same treatment outcome (at best) to clinically-significant return of fear (at worst), we find the argument against slow progression to be particularly compelling even if assertions regarding variability enhancing safety associations has not yet been fully realized in empirical studies.

2.2. Spaced scheduling of exposure trials

The use of variable inter-trial intervals, commonly referred to as an unmassed or expanding-spaced schedules of exposures, represents another way of enhancing the accessibility of newly-formed non-pathological associations (Craske et al., 2008) as well as a form of variability. Rowe and Craske (1998b) propose several critical components of an expanding-spaced schedule. To begin with, although spaced, random, and variable practices during training have been shown to impede learning during the acquisition phase, these factors actually enhance long-term retention of information (Schmidt & Bjork, 1992). Enhanced long-term retention from an expanding spaced schedule results in greater storage strength, thereby increasing the likelihood of successful retrieval (i.e., as compared to a massed schedule; Bjork & Bjork, 1992). Further, an expanding-spaced schedule may promote spontaneous retrievals of recently learned material simply because there is more time between exposure trials to successfully retrieve it (i.e., increased opportunity to recall safety based-associations; Bjork & Bjork, 1992).

Studies involving the direct manipulation of exposure schedules have yielded conflicting, inconclusive findings. Whereas some initial work detected an advantage for unmassed schedules in terms of return of fear at follow-up, generalization, or both (e.g., Rowe & Craske, 1998b; Tsao & Craske, 2000), several studies comparing massed and unmassed exposure trials have led to equivocal results (e.g., Bohni, Spindler, Arendt, Hougaard, & Rosenberg, 2009; Hendriks, L., de Kleine, Hendriks, G-J., & Minnen, 2015; Oldfield, Salkovskis, & Taylor, 2011). In one study examining individuals with OCD, Abramowitz, Foa, and Franklin (2003) reported that the intensive (massed) program was superior to the twice-weekly (unmassed) program in the short-term, but not at 3-month follow-up. In particular, there were no differences across treatment programs in symptom severity or clinically significant improvement at follow-up, which the authors noted was due to deterioration of gains in the massed group as opposed to continued improvement in the unmassed group. This result suggests that even when massed trials are associated with superior posttreatment effects, this may not translate to long-term outcomes.

As with many of the lines of research above, the extant literature on exposure schedules is plagued by a few key limitations. First, clients with spaced exposure trials often have homework to practice, which may serve to facilitate learning between sessions. Also, given that a massed schedule appears to be less intuitively appealing to clients (Chambless, 1990) and can, though not always, lead to higher drop-out rates (Tsao & Craske, 2000), many of these studies have been marked by substantial attrition in the massed conditions (cf. Hendriks, Kleine, Hendriks, & Minnen, 2015). Substantial inconsistency across studies regarding what is considered massed and unmassed as well as total treatment time must also be taken into account. In light of these shortcomings, as well as vast inconsistencies across the literature, it may behoove us to integrate differing schedules as one component of an exposure program with a broad emphasis on variability.

2.3. Offset reinstatement and context renewal effects

Shifting contexts across extinction training and subsequent renewal tests has also been proposed to have an impact on return of fear (e.g., exposure in a clinical room following by encountering feared stimuli in the outside world). As conceptualized by Bouton (1993), inhibitory associations reflective of safety learning (i.e., as compared to the original excitatory associations) are elicited and guide behavior only when the CS occurs in the same context as extinction. Accordingly, several methods for offsetting context renewal effects have been proposed, such as conducting exposure in multiple contexts and bridging the extinction and retest contexts through retrieval cues and mental reinstatement of the extinction context (e.g., the therapist and physical environment where treatment occurred). Though space limitations preclude us from reviewing the complex literature on context effects, we wish to note that extant studies examining context manipulations have used exclusively phobic samples and yielded highly inconsistent findings. Future work in this area could benefit greatly from testing proposed moderators of effects (e.g., whether clients originally acquired fears in different contexts as compared to a single context; Bouton, García-Gutiérrez, Zilski, & Moody, 2006), as well as exploring additional learning paradigms (e.g., ABC) and varied non-physical context shifts (e.g., time of day), in anxiety disorder samples other than individuals with specific phobia.

2.3.1. Retrieval cues

It has been theorized that retrieval cues from the extinction context may help disambiguate the meaning of the CS during renewal tests by retrieving the memory of extinction (Brooks & Bouton, 1994). In other words, such cues may activate newly-formed inhibitory associations reflective of safety learning as opposed to fear-based excitatory associations by bridging the extinction (i.e., exposure) and recovery contexts. Despite this strong theoretical rationale, the extant literature has yet to provide robust evidence for the efficacy of retrieval cues. In one of the more promising studies involving a standard human fear conditioning paradigm, Vansteenwegen et al. (2006) reported greater return of fear when the cue had been previously presented during *acquisition* as opposed to extinction; however, the use of retrospective expectancy ratings and lack of a control group limits interpretation. Using a similar paradigm, Dibbets, Havermans, and Arntz (2008) found that an extinction cue attenuated renewal of a previously-extinguished conditioned response (expectancy of a loud scream) following a context shift. However, the cue did not lead to generalization of safety learning to novel contexts. In the sole clinical study involving retrieval cues, Culver, Stoyanova, and Craske (2011) found only weak support for attenuation of context-dependent return of fear in one sub-study of participants with speech anxiety. This finding was also limited to self-report, with null results based on the behavioral and physiological measures. In another sub-study using contexts selected for maximum distinctiveness, all participants showed significant return of fear following a context shift irrespective of retrieval cue usage. Potential sources for this lack of effects included participant inattention to retrieval cues due to the presence of other threat-relevant stimuli and the use of minimally-salient cues (Culver et al., 2011).

Finally, there has been a paucity of research examining another proposed approach to offset context renewal, known as mental reinstatement or mental rehearsal of context (Craske et al., 2008). This technique can be considered an alternative form of retrieval cue, as it is theorized to operate through the same underlying mechanism (i.e., creating a bridge between contexts). In an empirical test of this method, Mystkowski, Craske, Echiverri, and Labus (2006) compared conditions in which spider-fearful participants were instructed to reinstate either the extinction context or an unrelated context following extinction training. Consistent with hypothesis, mental reinstatement of the treatment context significantly reduced return of fear relative to reinstatement of an unrelated context at a 1-week follow-up conducted in a novel context (2006). This preliminary finding provides support for the notion that bridging extinction and retest contexts may indeed offset context-dependent return of fear; however, the lack of follow-up studies aimed at replicating the effect limits confidence in that conclusion.

In addition to the limitations posed by the use of primarily nonclinical samples, research on the efficacy of retrieval cues is also plagued by contradictory theories regarding the risks of using such cues (e.g., Craske et al., 2014; Dibbets et al., 2008). Despite some contradictions in prediction, it seems safe to say that most theorists would agree that a retrieval cue that a person misinterprets as a reliable safety signal can become counter-productive in the same manner as a safety behavior. Attempting to use retrieval cues per se thus seems implausible as an effective clinical intervention, but mental reinstatement seems more promising. Helping clients learn to recall past successes when facing future anxiety-related challenges may be more likely to transfer safety-based associations developed through exposure to a novel context and thus merits further study.

2.4. Capitalize on reconsolidation

A final strategy proposed by Craske et al. (2014) to enhance accessibility and retrieval of newly-learned associations involves taking advantage of the reconsolidation process that occurs when already-stored memories are retrieved (Nader, Schafe, & LeDoux, 2000). Specifically, the experience of retrieving memories ultimately results in new neurochemical processes because the memory is written into long-term memory again upon retrieval. It has also been proposed that targeting reconsolidation mechanisms has the theoretical advantage of altering the threat representation, thereby diminishing reliance on prefrontal cortex circuitry and leading to more persistent reduction in fear responses (Schiller, Kanen, LeDoux, Monfils, & Phelps, 2013). Accordingly, Craske et al. hypothesize that introducing the feared stimulus (i.e., CS) for a brief period 30 min before repeated trials of exposure will weaken the fear memory itself by incorporating new material into the previous memory. This theory draws from research in rodent samples showing that a brief presentation of the CS prior to extinction training significantly reduces return of fear (e.g., Monfils, Cowansage, Klann, & LeDoux, 2009).

Studies targeting reconsolidation in humans using traditional fear conditioning paradigms have resulted in mixed findings (e.g., Kindt & Soeter, 2013; Schiller et al., 2010). A meta-analysis aimed at reconciling discrepant results across the rodent and human literature yielded a small-to-moderate effect of post-retrieval extinction for reducing return of fear in humans relative to standard extinction (Kredlow, Unger, & Otto, 2016). In the first clinical study, individuals with spider phobia who were exposed to a virtual spider ten minutes prior to a virtual reality exposure did not show improved outcomes relative to those who were exposed to a virtual plant (Shiban et al., 2015). However, interpretation of these findings is clouded by the use of differing exposure formats across posttreatment (virtual reality) and follow-up (in vivo). Most recently, Telch, York, Lancaster, and Monfils (2017) compared participants with naturally-acquired fears (i.e., spiders or snakes) who completed a 10-second fear reactivation procedure 30 min prior to (experimental) or following (control) exposure therapy. In addition to displaying significantly lower phobic responding at follow-up, the experimental group also demonstrated enhanced fear attenuation during the first few exposure trials (though controls ultimately reached similar fear levels).

Despite Telch and colleagues' encouraging finding, we maintain that it is premature to draw any conclusions about the efficacy of this technique in exposure therapy. In addition to inconsistent results using traditional fear conditioning paradigms, the two clinical studies targeting reconsolidation were so disparate methodologically that it is challenging to know what to make of the discrepant results between them. For example, in addition to employing different exposure modalities (i.e., virtual reality versus in vivo), the study designs also entailed differing durations of reactivation trial and waiting period following reactivation. Further, given the methodological complexities associated with capitalizing on reconsolidation in an exposure context (e.g., in terms of perfecting the timing and systematic presentation of the CS, conducting manipulation checks), as well as the potential for interference with extinction learning (e.g., if the brief stimulus presentation unintentionally serves as a form of incomplete or ineffective exposure), we caution against incorporating this strategy for the time being.

3. Integration and conclusions

Consistent with our evolving understanding of the processes underlying extinction learning, Craske and colleagues' inhibitory learning theory (Craske et al., 2008; Craske et al., 2014) was designed to enhance the efficacy of exposure therapy through a dual focus on developing new, non-threat associations and enhancing the accessibility and retrieval of these newly-learned associations over time and context. Of the exposure augmentation techniques reviewed above, the research literature most strongly supports elimination of safety behaviors. We interpret this empirical support as a more general implication that maximizing discrepancy between expected and actual outcomes has the most clinical promise at present; capitalizing on this mismatch is the proposed mechanism through which safety aid reduction operates. Consistent with this notion, all of the factors proposed to account for the pernicious role of safety behaviors in exposure therapy (e.g., misattribution of safety, diversion of attentional resources away from disconfirming information) implicate the pathway of reduced expectancy violation. In other words, exposures specifically aimed at disconfirming beliefs regarding safety behaviors (e.g., “I can't handle shaking someone's hand without sanitizing,” “Carrying around a Xanax keeps me safe”) allow the client to experience the situation as it really is, thereby leading to improved treatment outcomes. Emphasizing expectancy violation in particular may also illuminate differences in beliefs about safety behaviors being available versus using them, which is important in light of evidence that safety behavior availability and utilization may be conceptually distinct. Given the strong underlying theory and empirical literature base, we assert that maximizing mismatches with expectancies serves as a primary guiding principle to enhance the efficacy of exposure.

Thus, the inconsistent findings described above can be reconciled and a path forward can be forged when one considers optimizing expectancy violation to be the predominant focus. For example, with regard to minimizing distraction as well as incorporating cognitive techniques, the most integral factor to take into account is *function*: In the case of distraction, it would benefit clinicians to carefully examine whether the distractor in question is taking away from the client's opportunity to learn that the stimulus or situation is not as bad as anticipated, thereby acquiring the deleterious function of a safety behavior. In some cases, allowing oneself to be distracted (perhaps particularly by small-talk with a therapist) might emphasize that the situation is not as bad an anticipated: It is hard to believe a situation was really dangerous if it seemed appropriate to talk about the weather. Thus, what might appear to be a distraction could, for some clients, serve as a means of maximizing discrepancy with expectation.

Similarly, the addition of cognitive techniques allows for beliefs about potential outcomes to be explicitly identified and targeted. As we explored above, even if behavioral intervention alone (i.e., exposure) is the only required element of extinction learning, cognitive work may nevertheless be valuable for improving buy-in and compliance with exposure. At the same time, one must also keep in mind that expectancy violation is most potent when the discrepancy between expected and actual outcome is magnified. Consequently, future research and clinical practice should be focused on the efficacy of incorporating cognitive work that differs in function. That is, cognitive restructuring could be used to isolate client predictions and generate exposures to test those predictions (maximizing mismatch) or to reassure clients preemptively that bad outcomes are unlikely (minimizing mismatch). Knowing that cognitive techniques were used, or even when they were used (e.g., before versus after exposure), does not allow one to conclude whether their presence would necessarily maximize or minimize mismatch: The *way* the techniques are used may be far more important.

A second overarching strategy we believe should guide exposure interventions is *variability*. As is described above in detail, nearly everything that is known about the basic science of extinction and memory leads to the theoretical rationale that inhibitory learning is optimized when exposure is conducted using an assortment of stimuli (e.g., in terms of number and type) and methods of approach, across as many contexts as possible. Although there are noteworthy discrepancies in the research findings regarding the efficacy of differing exposure schedules and context-related interventions, variability, as an overarching goal, has sufficient support for recommendation for clinical use. Therapists using exposure techniques might do well to consider whether their current format for exposure really maximizes variability, or perhaps unintentionally limits it (e.g., due to slow progression through an exposure hierarchy or use of a small set of standard stimuli). As we discussed above, employing a combination of both massed and expanding-spaced schedules may in fact provide an optimal combination of mismatching expectancies and variation within exposure.

Regarding context effects, there are empirical reasons to believe that conducting exposure in the presence of as many maximally-distinct contextual stimuli as possible will provide the most potent, generalizable intervention. Additional experimental investigation of retrieval in novel contexts (i.e., ABC paradigms) will be integral to examining the role of variability within exposure. ABC paradigms may be more clinically-relevant given that (a) original acquisition contexts can be unknown or implausible to replicate and (b) encountering feared stimuli in a novel context is a relatively common source of return of fear (Balooch, Neumann, & Boschen, 2012). Thus, identifying factors that increase the likelihood of successful retrieval of extinction learning outside of the acquisition and exposure contexts is of the utmost importance in terms of clinical applications.

Given that Craske and colleagues (Craske et al., 2008; Craske et al., 2014) have advanced a sophisticated theoretical rationale, it is unfortunate that many of the studies examining the related strategies are characterized by methodological flaws and marked sample limitations. We want to be clear, however, that we do not mean to impugn the researchers who have attempted to test these issues. On the contrary, the fact that such problems arise so frequently should prompt researchers to consider the possibility that this may be a particularly challenging area for research, requiring even more careful consideration of methodological issues than usual. Nevertheless, the problems in many existing studies make it all the more difficult to know how to interpret the frequently equivocal or conflicting findings. In particular, the research evidence is lacking regarding whether deepened extinction, occasional reinforced extinction, affect labeling, and capitalizing on reconsolidation produce superior outcomes compared to exposure alone. Of these techniques, deepened extinction and affect labeling hold the most promise for exposure augmentation in terms of ease of implementation. Moreover, deepened extinction may also function as a form of variability, which has the potential to confer additional benefit.

In contrast, occasional reinforced extinction and capitalizing on reconsolidation are purported to operate through complex, memory-based processes. The operationalization of these processes in empirical studies have been plagued by potential confounds and, perhaps not surprisingly, have lacked consistent empirical evidence. The research needed to better understand any moderated effects of the medication DCS will also be complex, but may prove to be important to accomplish if moderators help identify clients who will show effect sizes for DCS that are closer to the large effects seen in the animal literature (Norberg, Krystal, & Tolin, 2008). Finally, several other techniques have shown promise for exposure enhancement, including fear antagonistic actions and brief bouts of exercise. Although there is reason to be cautiously optimistic about those future avenues for research, formal laboratory studies that directly test these interventions in clinical populations are warranted.

Collectively, research support for exposure augmentation techniques aimed at optimizing inhibitory learning has fallen short of theoretical expectation in several respects. Though the literature strongly suggests that this theory provides a better mechanistic explanation for the results of exposure therapy than alternatives such as EPT (at least as originally proposed), findings regarding particular enhancement strategies have been quite inconsistent; even among studies in support of specific techniques, the majority of effects are modest at best. This lack of large effects may simply reflect the challenges associated with translating basic science interventions into clinical practice, raising the question of whether large effects should even be expected. Alternatively, we may be better served to view Craske and colleagues' theory (Craske et al., 2008; Craske et al., 2014) as an overarching way to conduct exposure. Plausibly, the instances of failure of this theory to hold up to empirical investigation may be due, at least in part, to its division into smaller pieces based on specific mechanisms. Viewing inhibitory learning theory as a unified exposure paradigm, with dual foci on violating expectancies and incorporating variability, might be an ideal path to improving the efficacy of exposure.

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