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Conceptualizing Eating Disorder Psychopathology Using an Anxiety Disorders Framework: Evidence and Implications for Exposure-Based Clinical Research

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Abstract

Eating disorders (EDs) and anxiety disorders (ADs) evidence shared risk and significant comorbidity. Recent advances in understanding of anxiety-based disorders may have direct

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application to research and treatment efforts for EDs. The current review presents an up-to-date, behavioral conceptualization of the overlap between anxiety-based disorders and EDs. We identify ways in which anxiety presents in EDs, consider differences between EDs and ADs relevant to treatment adaptions, discuss how exposure-based strategies may be adapted for use in ED treatment, and outline directions for future mechanistic, translational, and clinical ED research from this perspective. Important research directions include: simultaneous examination of the extent to which EDs are characterized by aberrant avoidance-, reward-, and/or habit-based neurobiological and behavioral processes; improvement in understanding of how nutritional status interacts with neurobiological characteristics of EDs; incorporation of a growing knowledge of biobehavioral signatures in ED treatment planning; development of more comprehensive exposure-based treatment approaches for EDs; testing whether certain exposure interventions for AD are appropriate for EDs; and improvement in clinician self-efficacy and ability to use exposure therapy for EDs.

Keywords

Eating disorder; Anxiety; Exposure therapy

Eating disorders (EDs) and anxiety disorders (ADs) are often comorbid, with accumulating evidence of shared genetic risk for both forms of psychopathology (Pallister & Waller, 2008). Based on commonalities in risk factors, temperamental profiles, and clinical symptoms between these conditions, there has been renewed interest in adopting exposure-based paradigms for the treatment of EDs (Murray, Loeb, et al., 2016; Reilly et al., 2017). The current review presents a behavioral conceptualization of the overlap between anxiety-based disorders and EDs, with the larger goal of informing future research. For the purposes of the current review, we refer to EDs and ADs in broad terms. We include reference to the range of EDs and ADs defined in the Diagnostic and Statistical Manual of Mental Disorders – 5th edition (DSM-5; American Psychiatric Association, 2013). Further, we include discussion of obsessive-compulsive disorder (OCD) and posttraumatic stress disorder (PTSD), classified as ADs in previous iterations of the DSM, as these conditions also involve pathological anxiety in symptom presentation (American Psychiatric Association, 2013), demonstrate similar biobehavioral threat mechanisms to other ADs (Knowles et al., 2018; Lommen et al., 2013; McGuire et al., 2016; Pittig et al., 2018), are highly comorbid with EDs (Hudson et al., 2007; Kessler et al., 2013; Levinson, Brosof, et al., 2019), and exposure-based treatment approaches have been well-researched for these conditions (Pittig et al., 2018).

EDs have historically been separated from ADs within diagnostic classification systems (American Psychiatric Association, 2013; Andrews et al., 1999); however, ADs and EDs share a number of risk factors and clinical features, and often co-occur (Aspen et al., 2014). ADs are characterized by experiences of anxiety that are intense, persistent, and overwhelming in the absence of real danger, or out of proportion with the magnitude of true danger. Similar to ADs, core ED psychopathology involves significant anxiety and behavioral avoidance. For instance, intense fear of weight gain with consequent food restriction is a defining feature of anorexia nervosa (AN) and is present in other ED

diagnoses. Further, up to two-thirds of individuals with EDs report a lifetime AD (Bulik et al., 1997; Kaye et al., 2004), and ADs and EDs demonstrate prospective relationships with one another (Buckner et al., 2010; Micali et al., 2011; Micali et al., 2015; Schaumberg et al., 2018). Studies with genetically-informed designs also confirm shared transmission of ED and anxiety risk (Keel et al., 2005; Silberg & Bulik, 2005). Moreover, behavioral models identify avoidance learning (i.e., an operant response that is reinforced by escape from, or avoidance of, an aversive stimulus) as relevant for the development of EDs over time (Anestis, Smith, et al., 2008; Fischer et al., 2013). Avoidance learning, while not the exclusive factor supporting ED psychopathology, may play a key role as an ED maintenance mechanism.

In 2008, Pallister and Waller provided an account of the overlap between EDs and ADs. These authors outlined a cognitive model of anxiety, reviewed data on comorbidity between anxiety and EDs, hypothesized that safety behaviors and cognitive avoidance act as shared mechanisms across both presentations, and offered treatment recommendations from this perspective (Pallister & Waller, 2008). As etiological and treatment models of ADs have evolved in recent years (L. A. Brown et al., 2017; Craske et al., 2014; Craske et al., 2018), the time is ripe to reevaluate the conceptual overlap between anxiety and EDs, incorporating updated literature. For example, the Pallister and Waller (2008) review was published before the commencement of neurobiological and behavioral work examining the role of inhibitory learning theory in the ADs. Moreover, given recent theoretical proposals to revisit the application of exposure therapy to EDs (Koskina et al., 2013; Murray, Loeb, et al., 2016; Murray, Treanor, et al., 2016; Reilly et al., 2017; Steinglass et al., 2011), an updated conceptualization of the link between ADs and EDs will benefit research in this area. Another compelling reason to elucidate shared processes between ADs and eating pathology is to optimize the application of exposure therapy for EDs (Murray, Loeb, et al., 2016; Murray, Treanor, et al., 2016; Reilly et al., 2017). While exposure-based treatments for ADs have evolved in recent years (Craske et al., 2014), transdiagnostic ED treatment has not progressed in a manner that maximally harnesses this knowledge (Reilly et al., 2017). Accordingly, a renewed discussion of how improved understanding of anxiety-based processes in EDs might enhance the efficacy of exposure therapy for EDs is warranted. While exposure-based protocols are unlikely to serve as comprehensive, stand-alone psychotherapies for EDs, integration of up-to-date knowledge of exposure-based approaches could improve their efficacy and utility when they are integrated into existing approaches such as family-based treatment and cognitive-behavioral therapy (CBT).

In sum, revisiting the overlap between ADs and eating pathology offers an opportunity to enrich research on the etiology and maintenance of transdiagnostic ED symptoms as well as inform novel treatment developments. To promote future work in this area, the current paper will: (1) identify ways in which anxiety, as a broad phenotype, may present in EDs; (2) explore specific anxiety phenotypes relevant to EDs and suggest ways to adapt exposure-based ED treatment based on this knowledge; (3) consider distinct features of EDs that may undermine or limit the use of exposure-based approaches; and (4) outline relevant directions for future mechanistic, translational, and clinical ED research relevant to the optimization of exposure therapy for this population.

Core symptom characteristics

EDs are characterized by abnormal eating habits, and include AN, BN, BED, avoidant-restrictive food intake disorder (ARFID), and other specified feeding and eating disorders (OSFED). As outlined in the DSM-5, AN symptoms include persistent restriction of intake leading to low body weight, fear of weight gain, and body image disturbance. BN symptoms also include body image disturbance, with frequent episodes of loss-of-control eating (i.e., binge eating) and compensatory behaviors (e.g., restricting, purging) (American Psychiatric Association, 2013). BED involves binge-eating behavior in the absence of compensatory behaviors; ARFID is characterized by food avoidance and resulting malnutrition or impairment without fear of weight gain. Finally, OSFED is used to characterize individuals with clinically significant eating pathology that does not satisfy criteria for another ED (American Psychiatric Association, 2013). Behavioral and cognitive features of EDs often overlap across diagnostic categories, and research indicates relatively high rates of diagnostic crossover among EDs over time (Eddy et al., 2008; Fichter & Quadflieg, 2007). Recent recommendations highlight the need for greater diagnostic inclusivity in ED research (Garber et al., 2019; Keel, 2019; K. E. Smith et al., 2018; Thompson & Park, 2016), and a mechanistic understanding of fear and avoidance processes is relevant to many ED symptoms. Considering striking commonalities in symptoms and their function across EDs, we take a primarily transdiagnostic lens to ED symptoms in the current paper.

Characteristic symptoms of EDs may share features and functions with symptoms of ADs. The hypothesized function of core symptoms of ADs is well-characterized; behavioral learning theories posit that pathological anxiety is often promoted and maintained via learned fear responses to aversive stimuli. Fear conditioning occurs when a neutral or conditioned stimulus (CS, such as a spider) is paired with an aversive unconditioned stimulus (US, such as a painful bite). When the CS and US are repeatedly (or memorably) paired (CS-US), individuals may develop threat-based associations between the two stimuli, such that the CS elicits a conditioned fear response (CR). Fear responses may become overgeneralized if individuals subsequently avoid contact with perceptually-similar stimuli. Once a threat-based CS-US association is established, individuals may attempt to neutralize perceived threatening stimuli via avoiding it or using *safety behaviors* aimed at minimizing the likelihood of harm. Because avoidance and safety behaviors temporarily reduce anxiety and are thus negatively reinforced, it becomes increasingly likely that these responses will be used in future anxiety-provoking situations. However, these responses contribute to disorder maintenance, as they eliminate opportunities for individuals to experience a violation of previously learned threat-based associations. In accordance with this model, ED behaviors may arise from repeated pairing of a US (e.g., perceived social rejection, interoceptive discomfort), with a once-neutral stimulus (e.g., weight gain, high-fat foods) that becomes a CS over time. As these US-CS associations are prevalent throughout society, they may be solidified via repeated direct experience or, in some cases, through social modeling. In contrast with the study of ADs, the processes defining ED-specific fear conditioning have not been fully evaluated, with little attention to the potential range of USs that could give rise to primary ED-related fears. One measurement has been developed to specifically measure and define ED-related fears; use of this measure in a sample of college

students found that weight gain consequences such as judgement and interoceptive fears are most 'central' in an ED symptom network, highlighting the potential primacy of these experiences in ED-relevant fear conditioning (Levinson & Williams, 2020). Over time, ED behaviors may function to avoid or escape anticipated threats (e.g., weight gain) and associated unpleasant internal experiences (e.g., feelings of guilt) (Berg et al., 2013; Haynos et al., 2017).

In the following section, we outline common symptoms observed in ED diagnoses that may serve similar functions to the pathological cognitive and behavioral symptoms implicated in AD onset and maintenance. We outline additional ED symptoms that may serve an avoidance function in Table 1.

Fear of fatness and weight gain.

Fears of fatness/weight gain are central symptoms for many individuals across the spectrum of EDs (Levinson et al., 2017). In a manner similar to ADs, fears of fatness/weight gain may represent learned responses that drive avoidance behaviors; therefore, identifying and challenging fears of fatness/weight gain in the context of treatment may present an effective way to target downstream maladaptive behaviors (e.g., caloric restriction, purging) .

Food avoidance.

Preliminary evidence of anxiety-related learning processes in individuals with EDs suggests that, similar to avoidance behaviors reported by individuals with ADs, avoidance of specific foods likely develops in part through both fear and disgust conditioning and may be maintained via negative reinforcement processes (Hildebrandt et al., 2015; Treasure et al., 2012). Individuals with EDs may engage in restrictive behaviors that facilitate avoidance of aversive states (e.g., anxiety, fear, disgust) linked via prior learning with food consumption (Haynos et al., 2017). While food avoidance without fear of weight gain is a hallmark symptom of ARFID, the extent to which non-weight- and shape-related fears associated with specific foods may drive or maintain other ED presentations is currently unclear.

Binge eating and compensatory behaviors.

Across ED presentations, binge eating and compensatory behaviors (e.g., self-induced vomiting, laxative use) are posited to serve an escape or affect regulation function (Heatherton & Baumeister, 1991). In particular, evidence from transdiagnostic ecological momentary assessment (EMA) and laboratory studies indicates that binge eating and compensatory behaviors reduce negative affect, which maintains such symptoms via negative reinforcement (Engel et al., 2013; Evers et al., 2018; Smyth et al., 2007). In this way, some ED behaviors may function in a similar manner to behavioral avoidance or safety behaviors in ADs.

Evidence of shared biobehavioral characteristics of ADs and EDs

Anxiety-based models of eating pathology (M. Brown et al., 2017; Hildebrandt et al., 2012; Murray et al., 2018; Murray, Treanor, et al., 2016) often draw upon extensive overlap between genetic risk factors, neurocognitive deficits, and temperament and personality traits

between anxiety and EDs (Kaye et al., 2004; Kerr-Gaffney et al., 2018). In the following section, we describe a range of biobehavioral features commonly observed across both EDs and ADs.

Genetic risk.

Decades of twin, family, and adoption studies highlight that EDs are genetically-linked (Trace et al., 2013), with heritability estimates between 40-60% (Trace et al., 2013). Further, there is evidence of shared transmission of anxiety and ED pathology (Jacobs et al., 2009; Lilenfeld et al., 1998; Silberg & Bulik, 2005), including relationships between specific diagnoses (e.g., AN and OCD (Cederlöf et al., 2015; Lilenfeld et al., 1998)). Recently, molecular genetic studies have begun to explore shared liability across psychiatric phenotypes using genome-wide data. For instance, in a study of shared heritability among select psychiatric illnesses, a moderate genetic correlation (r_g = .47) emerged between AN and OCD (the only ED and anxiety-based disorder included in analyses), providing evidence that similar genes may be operative in both phenotypes (Brainstorm Consortium et al., 2018). Recent research from the Psychiatric Genomics Consortium further supports a substantive genetic correlation (r_g = .25) with broad anxiety disorder diagnoses (generalized anxiety disorder, panic disorder, specific phobia, agoraphobia, or social anxiety disorder [SAD]) and AN (Watson et al., 2019)

Neurocognitive processes.

Emerging evidence suggests that shared neurocognitive processes, including heightened attention bias toward threat and cognitive inflexibility, are central to the risk and maintenance of rigid avoidance and safety behaviors in ADs and EDs. Heightened attentional bias towards threat (e.g., tendency to allocate attention towards threatening stimuli, relative to neutral/safe stimuli), contributes to the etiology and maintenance of ADs via increased attention towards and difficulty disengaging from threat stimuli (Cisler & Koster, 2010; Mathews & MacLeod, 2005). Attention bias towards threat is also a neurocognitive trait linked with EDs, with consistent evidence that individuals with EDs have enhanced attention bias towards both disorder-relevant and non-ED threat stimuli (Aspen et al., 2013; Stojek et al., 2018).

Cognitive flexibility, or the ability to adaptively shift between cognitive sets (i.e., set-shifting) and modify behavioral responses when contingencies change (i.e., reversal learning), allows individuals to adaptively regulate thoughts and actions in response to changing environments. Deficits in cognitive flexibility are posited to contribute to inflexible behavior patterns in both ADs and EDs (Lopez et al., 2008; Wildes et al., 2014). Difficulties with cognitive flexibility are evident in core features of EDs, including inflexible behaviors around eating-related issues (e.g., eating foods in a certain order, eating at a particular pace or at certain times of day), rigid rituals around the daily routine, and difficulties in identifying alternative ways to cope with problems (Roberts et al., 2010; Tchanturia et al., 2014).

Temperament and personality traits.

A number of personality traits and temperamental characteristics are associated with both ADs and EDs; those that may particularly impact behavioral avoidance include harm avoidance, intolerance of uncertainty, and perfectionism. The temperamental trait of harm avoidance, or the tendency to inhibit actions and behaviors in anticipation of perceived risks and potential harm, is a core temperamental feature associated with anxiety-related psychopathology (Cloninger et al., 1994). Elevated levels of harm avoidance are often present in EDs (Cassin & von Ranson, 2005; Farstad et al., 2015). Further, individuals diagnosed with comorbid current ED and lifetime AD report the highest levels of harm avoidance (Kaye et al., 2004), followed by those who have a remitted ED and lifetime AD and those who have an active ED and no lifetime AD. Individuals with an ED in remission and no lifetime AD also reported higher harm avoidance compared to healthy control women, suggesting that this characteristic may simultaneously increase risk for both ADs and EDs.

Intolerance of uncertainty, a tendency to experience uncertainty as extremely aversive, is a dispositional characteristic commonly observed in ADs (Yook et al., 2010) and is associated with a range of maladaptive affective, cognitive, and behavioral responses to perceived uncontrollable and unpredictable events. More recently, researchers have proposed that intolerance of uncertainty is relevant to the conceptualization and treatment of EDs (M. Brown et al., 2017; Haynos et al., 2020). Specifically, increased anxiety in EDs may enhance uncertainty regarding one's weight trajectory and recovery (Kesby et al., 2017), and ED symptoms may serve as a way of coping with uncertain situations (M. Brown et al., 2017). Further, difficulty with tolerating uncertainty may precipitate an overreliance on verbal rules (i.e., explicit, stated rules as to how one should behave, such as rules regarding dietary restriction), as opposed to experiential learning (i.e., changing behavior as contingencies in the environment change, such as the negative effects of ED behaviors) and contribute to the persistence of ED symptoms over time (Merwin et al., 2011).

Elevated levels of perfectionism are also often present among individuals with EDs (Bardone-Cone et al., 2007) and, to a lesser extent, ADs (Limburg et al., 2016), and perfectionism may represent a transdiagnostic risk factor for both forms of psychopathology (Egan et al., 2011). Models elucidating links between perfectionism and psychopathologies suggest that a pathological overemphasis on striving and achievement contributes to the pursuit of inflexible standards (e.g., appearance or eating standards in EDs, performance standards in social AD), which may result in rigid, rule-bound behaviors intended to maximize achievement and minimize perceived failure (Egan et al., 2011).

Overlap with Specific Anxiety-Based Disorders.

In addition to broad risk factors cutting across AD and ED risk, some specific AD presentations associate with particular ED features. In Table 2, we outline relevant areas of overlap between specific ADs and eating pathology, including (1) documented co-occurrence of a given diagnostic category with EDs in prior research and (2) conceptual overlap between a given AD with eating pathology.

Features of EDs that are Distinct from ADs.

While many features are shared across EDs and ADs, some distinct features of EDs may impact the implementation of exposure-based strategies. We introduce these features below, and expand upon how these distinctions may impact the use of exposure-based strategies later in the manuscript

The likelihood of certain feared outcomes.

Contemporary exposure therapies for ADs may seek to aid individuals in violating two primary expectancies. The first expectancy relates to the likelihood of a specific outcome (e.g., in the context of ADs, being bitten by a snake; being socially rejected). A second expectancy includes whether the negative outcome was 'as bad' as expected, for instance, whether difficult thoughts, sensations, or experiences occurring while in a feared context were experienced as 'overwhelming but manageable' vs. 'intolerable'. For many ED-related fears, the likelihood a self-reported 'feared outcome' may be quite high. While individuals with ADs may also encounter feared outcomes (e.g., negative social evaluation, re-traumatization), and the likelihood of these outcomes may vary across patients, some ED-related 'feared outcomes' are not just possible outcomes, but a likely feature of recovery. For instance, a commonly-reported fear of individuals with EDs is that treatment will lead to weight gain. For patients who are maintaining a weight below their biological set point, eating regularly *will* lead to weight gain (Murray et al., 2017). Indeed, this is a primary target of treatment for underweight individuals. Although most underweight individuals with EDs ultimately maintain a weight consistent with a healthy body mass index (BMI), a minority of patients will exhibit weight increases resulting in BMIs in the overweight or obese range (Murray et al., 2017). In a society that adopts thin-ideal standards, negative social consequences and stigma against higher weight bodies exist, reinforcing patients' negative views towards weight gain (Puhl & Suh, 2015). Additionally, body dissatisfaction is a common response to weight gain in non-ED individuals (Keys, Brožek, Henschel, Mickelsen, & Taylor, 1950), typically takes longer to resolve than disordered eating behaviors (Bachner-Melman et al., 2006), and may be present months after weight restoration. This is consistent with patients' fears that negative ED-related cognitions will persist after modifying their eating behaviors. Finally, many individuals with EDs fear that if they approach food, they will be unable to stop eating and may engage in binge-eating behavior. Binge eating and loss-of-control eating may occur following periods of semi-starvation (Stice et al., 2008), and this fear may be confirmed during initial phases of recovery for some patients. As weight gain, body dissatisfaction, and loss-of-control eating are examples of not just plausible but likely experiences for many individuals throughout ED recovery, focus on violating expectancies related to likelihood of these outcomes may be a less effective strategy. Instead, violating expectancies related to the *intensity/degree* of the outcome, *severity of distress* accompanying these outcomes, and the *tolerability* of the outcomes may be crucial when considering how to challenge expectancies in ED treatment.

The role of reward in EDs.

One notable difference between anxiety and EDs is the potentially important role of reward and positive reinforcement in certain ED symptoms. Studies utilizing EMA of ED behavior

in the natural environment have shown that positive affect increases after engaging in weight loss behaviors across multiple ED diagnoses (Engel et al., 2013; Haynos et al., 2017; Smyth et al., 2007). Other data have suggested that positive affect may also increase or stabilize following self-induced vomiting and loss-of-control eating episodes, although these findings have varied across samples and are inconsistent in nature (Haedt-Matt & Keel, 2011; Schaefer et al., 2020). Further, ED-related cues, including low-calorie foods, thin bodies, and images of exercise activate neural circuitry associated with reward processes in ED samples (Engel et al., 2013; Fladung et al., 2009; Foerde et al., 2015; Haynos et al., 2020). Animal models of EDs further highlight the potential role of reward in ED maintenance through evidence of increased dopaminergic response to both eating and physical activity in food-restricted states (Avena & Bocarsly, 2012). This suggests that, unlike ADs, which are largely maintained through avoidance or escape of negative outcomes, ED behaviors may be additionally motivated by pursuit of positive outcomes. Consistent with this hypothesis, individuals with EDs report that certain ED behaviors, especially those associated with the potential for weight loss, are highly valued (Gale et al., 2006; Mulkerrin et al., 2016; Skårderud, 2007). Clinically, this may manifest as individuals with EDs exerting effort to maintain certain behavioral symptoms (e.g., calorie restriction), feared beliefs (e.g., fear of weight gain), obsessions, and/or compulsions because these symptoms assist in achieving the valued goal of weight loss (Essayli & Vitousek, 2020; Garner & Bemis, 1982), increase a sense of pride and self-control (Skårderud, 2007), and/or contribute to their identity (Rich & illness, 2006). Additionally, rigid schemas that tie self-worth to weight control may be positively reinforcing in and of themselves, as they serve to reduce ambiguity and facilitate simplicity, structure, and certainty (Vitousek & Hollon, 1990).

Compromised nutritional status.

An additional prominent characteristic of many EDs is low weight and/or inadequate nutritional status. Studies highlight impairments in neurocognition during acute and sustained periods of starvation (Pender et al., 2014; Zwipp et al., 2014), which may impact the effectiveness of certain interventions, including those dependent on consolidation and recall of psychotherapeutic experiences. In addition, compromised nutrition may induce hormonal changes among those with EDs, including low estrogen availability (Shufelt et al., 2017). Research on fear extinction learning has recently indicated that low estrogen states are associated with deficits in fear extinction recall among both rodents and female humans, suggesting that the efficacy of exposure-based approaches for treating anxiety-related conditions may be compromised when females are in low-estrogen states (Garcia et al., 2018; Graham & Milad, 2013). Low estrogen availability stemming from nutritional deficits may thus limit or otherwise impact extinction learning among those with EDs.

Treating the Overlap: Anxiety-Based Intervention Approaches

Altogether, EDs and anxiety-based disorders evidence significant overlap along with a few key discrepancies. Given considerable overlap in the clinical features and associated biobehavioral characteristics between ADs and EDs, empirically-based treatments for ADs may hold promise as adjunctive or alternative treatment approaches for eating pathology (Hildebrandt et al., 2012; Koskina et al., 2013; Reilly et al., 2017; Steinglass et al., 2011).

Exposure-based interventions are currently regarded as the gold-standard treatment for a range of ADs (Hofmann & Smits, 2008; Olatunji et al., 2010). These treatments aim to facilitate new learning through encouraging clients to repeatedly approach feared stimuli (i.e., the CS) and refrain from engaging in anxiety-reducing behaviors (e.g., rituals or safety behaviors (Abramowitz, 2013)).

Early theories emphasized habituation as the primary mechanism through which exposure produces long-term reductions in anxiety symptoms (Foa & Kozak, 1986). Specifically, the learned CS-US association was theorized to be weakened through repeated presentations of the CS (e.g., spider) without the US (e.g., pain) until the CR (e.g., fear) abates. More recent evidence suggests that successful exposure operates through inhibitory learning, whereby individuals learn new, non-threat associations between the CS and the absence of the US (CS-no US). Contemporary accounts of exposure mechanisms theorize that the strengthening of these CS-no US associations eventually overpowers the previously learned CS-US associations (Craske et al., 2014; Craske et al., 2008; Craske et al., 2012). Updated treatment approaches employing this framework seek to enhance the potential “expectancy violation/’ or degree to which patients’ expectations regarding the CS-US link are disconfirmed (Arch & Abramowitz, 2015; Craske et al., 2014; Craske et al., 2008; Craske et al., 2012). For example, patients are asked to explicitly and specifically identify what they expect will happen if they confront a feared stimulus (e.g., if I am in the same room with a spider, it will bite me within 30 seconds), and then reflect on how their expectancies aligned with their experience during the exposure afterwards. Consistent with this perspective, treatment-effectiveness studies suggest strategies that maximally violate expectancies are useful for decreasing anxious symptoms (Craske et al., 2008; Craske et al., 2012).

Past Exposure-Based Work in EDs.

Exposure-based approaches for EDs were first adapted in the 1980s, and were primarily modeled on exposure and response prevention (ERP) protocols for ADs. In these studies, individuals with BN were exposed to feared “binge foods” and subsequently asked to refrain from engaging in compensatory safety behaviors (Leitenberg et al., 1988; Wilson et al., 1986). Later adaptations used exposure techniques to combat restrictive eating (Steinglass et al., 2012), binge-eating behaviors (Bulik et al., 1998; Cooper et al., 1995; Schmidt & Marks, 1989), and ED-related body image disturbances via confronting one’s image in a mirror (Delinsky & Wilson, 2006; Griffen et al., 2018). These early efforts to adopt exposure for EDs yielded generally positive findings but with marginal improvements over traditional therapies, which tempered enthusiasm for further translation of exposure-based approaches to ED treatment. However, recent theoretical writing has proposed revisiting exposure for EDs (Koskina et al., 2013; Reilly et al., 2017). These authors note several potential explanations for marginal effect sizes in prior studies, including substantive methodological issues (e.g., lack of control group, small sample sizes, applications that focused exposure to food cues [e.g., binge foods] that are not feared stimuli). Further, the majority of studies examining exposure treatments for EDs were conducted in an era when habituation-based models dominated the field. More recently, treatments for ADs and their underlying theoretical models have advanced (e.g., inhibitory learning framework), offering novel methods for targeting disorder-maintaining mechanisms in EDs (Craske et al., 2014;

Koskina et al., 2013; Reilly et al., 2017). For example, instead of focusing on habituation to "feared foods," novel exposure intervention development might focus on violating expectancies related to the consequences of consuming feared foods. Similarly, interventions may focus on expected vs. experienced consequences of engaging in behaviors that may heighten body-related anxiety, such as trying on new clothes or wearing a swimsuit at the beach, with a focus on predictions and outcome expectancy violation. In the following section, we elaborate further on ED-AD treatment implications based on more specific exposure-based approaches currently used in AD treatment.

Exposure to feared ED-related stimuli.

ED-related fears may be conceptualized as phobic stimuli, and exposure in this context would include facilitating approach toward CSs (e.g., eating specific foods, wearing certain clothes) linked with a feared outcome (e.g., weight gain and/or social sequalae), to encourage learning that these outcomes often do not occur and/or are tolerable when they do (Levinson et al., 2014). As an example, once weight has stabilized for previously underweight patients, comparison of expected weight gain trajectories with actual weight changes week-to-week may be particularly useful for enhancing expectancy violation that is central to inhibitory learning. Virtual reality-based or imaginal exposure paradigms may also be used to target fears of longer-term weight gain and potential ramifications of obesity (Levinson et al., 2014). In addition, pairing multiple cues together (e.g., in EDs, pairing wearing tight clothing with going to an avoided social engagement) may enhance exposure efficacy.

Increasing present-moment awareness and experiential acceptance to reduce worry and repetitive negative thinking.

Current approaches to treat worry include identifying process-characteristics of excessive worry and other repetitive thought, approaching feared cognitions and related emotions, reframing beliefs about worry, and increasing present moment awareness (i.e., mindfulness) (Farchione et al., 2012; Twohig & Levin, 2017). Using this framework, behavioral treatment of ED symptoms could include: increased focus on identification of repetitive negative thoughts as they pertain to shape, weight, and eating; concentration on understanding the function of this process and the individual's beliefs about this worry (rather than focusing on specifically challenging the thoughts themselves); promoting acceptance and approach of feared consequences and stimuli; and exposure to weight- and shape-related emotional experiences (Reilly et al., 2018). Further, as therapy progresses, individuals could be encouraged to generalize these approaches beyond weight, shape, and eating-related anxieties to other anxious experiences.

Exposure and response prevention for compulsive behaviors.

Effective exposure therapy for compulsive behaviors directs patients to confront obsessional thoughts while discontinuing compulsions (Abramowitz & Jacoby, 2015). From this perspective, exposure therapy for EDs could be effective specifically by targeting obsessional thinking. This may be accomplished through imaginal exposure, in which feared obsessions are deliberately evoked and allowed to remain present in one's mentation for a prolonged duration. Preliminary evidence supports imaginal exposure as an effective

approach for reducing ED symptom severity (Levinson et al., 2014; Levinson & Rodebaugh, 2016). Another potential strategy to confront obsessional thoughts in EDs is to encourage patients to deliberately "invite" these thoughts and allow them to be present during *in vivo* exposures (while refraining from safety behaviors). For example, during exposure to eating a feared food, a patient may be encouraged to deliberately encounter intrusive thoughts about gaining weight and/or becoming fat. Such an approach is consistent with the suggestion to combine multiple fear cues in exposure with the aim of enhancing extinction learning (Abramowitz et al., 2018).

Another important treatment consideration involves the need to discourage patients from engaging in behaviors that reduce anxiety during and after exposure. In exposure-based treatment of OCD, for instance, compulsive rituals are conceptualized as a chief maintaining factor due to their disruption of the recommended learning experiences that patients must have (Blakey & Abramowitz, 2016) which are accordingly targeted in treatment. Whereas most clinicians are likely to discourage ED behaviors that pose significant health risks (e.g., purging), there is less emphasis on eliminating other anxiety-reducing behaviors (e.g., body checking, subtle exercising, distraction strategies) that may interfere with exposure-based learning (Sloan et al., 2002).

Interoceptive exposure (IE) for hypersensitivity to physical sensations.

Individuals with EDs may benefit from developing corrective learning experiences around the perceived dangerousness of interoceptive sensations, such as fullness and gastric discomfort (Boswell et al., 2013; Butler et al., 2006). IE may augment existing therapies for EDs by increasing the tolerability of uncomfortable body sensations (Boswell et al., 2015; Hildebrandt et al., 2014; Zucker et al., 2017). Relevant to applications for EDs, IE has also been expanded to target anxiety-related disorders characterized by gastric hypersensitivity, including irritable bowel syndrome (Craske et al., 2011), as well as pain, distress, and negative affect in children with functional abdominal pain (Zucker et al., 2017). Applied to EDs, IE could be used to address both global somatic sensitivity and more ED-specific sensitivity (Boswell et al., 2015). ED-specific exercises include gulping water/water loading (to simulate excessive fullness/bloating), wiggling the body, bouncing up and down (feeling body fat, skin, muscles move/jiggle), pushing stomach out (tight stomach, bloating), wearing tight clothing especially around the abdomen (tactile discomfort, tightness), and smelling or tasting certain avoided foods (gastric functions) (Boswell et al., 2015). To help deepen extinction, IE could be paired with other types of exposures to help challenge food avoidance due to fullness (e.g., wearing tight clothing while consuming a meal) or body image distortion (e.g., gulping water to simulate bloating and then engaging in a mirror exposure). Preliminary evidence suggests that the inclusion of adjunctive IE may confer benefit for treatment-seeking adults with EDs receiving CBT (Boswell et al., 2019), as well as for low weight adolescent with EDs receiving family-based therapy (Hildebrandt et al., 2014; Plasencia et al., 2019). Additionally, IE is a component of CBT for ARFID, which appears to be a promising treatment (Thomas & Eddy, 2018).

Social exposures.

Research indicates that the experience of social anxiety is a barrier for help-seeking and negative prognostic factor in individuals with EDs, decreasing engagement in effective treatments (Goodwin & Fitzgibbon, 2002). Eating and drinking in public along with social appearance anxiety should be targeted in individuals who present with these fears. Many of these exposures are inherent, but currently unstandardized, in ED treatment; therefore, implementation should closely follow evidence-based protocols (Hope et al., 2010) that focus on the individual experiencing (and not avoiding) anxiety associated with such situations. Exposures focused on social appearance anxiety (e.g., receiving feedback on one's appearance from a confederate) and perfectionism (e.g., purposely making mistakes) may also be helpful in the treatment of both SAD-EDs simultaneously. As individuals with EDs often report body shame (Duarte et al., 2016), imaginal exposure to both past experiences that evoked shame as well as *in vivo* exposure to current experiences associated with these emotions (e.g., mirror exposure, wearing a swimsuit in public) may be useful in challenging the notion that the experience of this negative emotion would be intolerable.

Imaginal exposure for distal negative outcomes.

Prolonged imaginal exposure, a gold standard treatment for PTSD, may also be a useful strategy in the treatment of core fears, including fear of weight gain, in EDs (Levinson et al., 2014). While individuals may experience some gradual weight gain during the course of treatment, imaginal exposure may be both useful and practical for exposure to fears surrounding *significant* weight gain and the consequences associated with this potential outcome.

Components that may undermine or limit the use of exposure-based approaches in EDs

Although there is considerable overlap in the phenomenology and putative mechanisms associated with anxiety and EDs, it is important to consider the adaptation of exposure-based approaches in relation to both shared and unique features of these conditions. In this section, we outline barriers that may compromise the implementation of exposure therapy among individuals with EDs and thus are critical to consider in future research exploring this approach in this population.

The likelihood of certain feared outcomes.

As noted earlier, normalizing eating behaviors may *increase* the likelihood that individuals with EDs experience certain feared outcomes, such as weight gain, body dissatisfaction, and/or weight-related stigma and disapproval from others (Bachner-Melman et al., 2006; Keys et al., 1950; Murray et al., 2017; Puhl & Suh, 2015). The potential for these negative outcomes warrants attention when pursuing exposure-based treatment for EDs. First, the timing of exposure-based interventions may need to be adjusted to ensure expectancy violation over confirmation. For instance, clinicians should consider how exposure therapy during acute weight restoration may inadvertently reinforce false beliefs that consumption of certain types of food lead to weight gain and associated negative consequences (Murray,

Loeb, et al., 2016; Murray, Treanor, et al., 2016). At the same time, preliminary evidence suggests that frequent exposure to feared foods can be helpful during the weight restoration phase of treatment (Cardi et al., 2019; Essayli et al., 2017; Hildebrandt et al., 2014; Sepúlveda et al., 2017), perhaps because patients with EDs often overestimate the magnitude of feared outcomes (Simmons et al., 2002), thereby violating expectations associated with weight gain. Thus, while exposure to feared foods may be an effective intervention for patients undergoing weight restoration, identification of more nuanced and specific feared outcomes (e.g., rate of weight gain rather than weight gain per se; social consequences of weight gain rather than body dissatisfaction) may enhance opportunities to highlight expectancy-outcome discrepancies during weight restoration.

In addition to considerations related to timing, it may be the case that shifting to an acceptance- and tolerability-based exposure framework will be a useful approach for feared outcomes that are highly likely (or expected) to occur (Linde et al., 2015; Merwin et al., 2013; Zucker et al., 2019). For instance, with regards to potentially accurate fears about weight gain and its societal implications, focusing on an individual's ability to tolerate the experience of living in a larger body along with acceptance of the uncertain nature of weight trajectory could be useful targets related to weight and shape, as compared to attempts to disprove client fears about the likelihood of weight gain. Some approaches to helping both patients with ADs and EDs navigate negative affect during therapeutic exposures include encouragement to tolerate distress. Such approaches rest upon the belief that experiencing the ability to tolerate discomfort in the exposure will result in *both* reduction of negative affect (i.e., habituation) and an increase in self-efficacy for fully experiencing difficult emotions and sensations (i.e., expectancy violation related to the degree and tolerability of feared outcomes). Ultimately, habituation and inhibitory learning may both contribute to the effectiveness of ED exposures, though these two models have not yet been disentangled in relation to ED outcomes. As habituation is not a ubiquitous experience reported by ED patients, and some feared outcomes may be likely and persistent, cultivating increased acceptance of persistent negative affective states, consistent with an inhibitory learning model, may be particularly germane when conducting ED-relevant exposures (L. A. Brown et al., 2017; Craske et al., 2014; Hayes & Hofmann, 2017).

Considering the role of reward in ED symptom maintenance.

As patients may value cognitive ED symptoms, the proposition of minimizing these symptoms or their impact on behavior may not be motivating (Essayli & Vitousek, 2020; Garner & Bemis, 1982). The degree to which exposure treatment can be effective for behaviors maintained through positive reinforcement-based processes is unknown; therefore, it is possible that additional or alternative intervention approaches may be needed for certain ED populations or symptoms. For example, it may be helpful to augment exposure-based interventions with strategies that encourage individuals to identify and engage in non-ED behaviors that facilitate positive affect and intrinsic reward. Treatments including components that target positive affect have recently shown promise among individuals with depression and anxiety (Craske et al., 2019) and may assist in allowing patients to experience reward outside of their ED, and for ED behaviors which serve a primarily rewarding function.

Another way to address the reward function of ED behaviors in the context of exposure-based interventions may be to integrate motivational enhancement techniques. Although research evaluating motivational interviewing as a treatment for EDs has been disappointing (Dray & Wade, 2012), empirically-supported CBT manuals for EDs recommend integrating motivational enhancement strategies alongside cognitive and behavioral interventions (Fairburn, 2008; Waller et al., 2007.) Examples of motivational enhancement strategies include: discussing the pros and cons of maintaining versus changing eating behaviors and weight status; envisioning a future defined by the pursuit of starvation and comparing this to a future following weight gain and full recovery from an ED; and exploring the degree to which an ED is consistent and inconsistent with one's values and future goals (Essayli & Vitousek, 2020; Vitousek et al., 1998). Further research is needed to evaluate the degree to which integrating motivational strategies may be useful at persuading individuals with EDs to engage in exposure interventions that ask them to forego potential positive affect they may derive from weight-related cognitions and eating behaviors.

Altered nutritional status in EDs.

Interventions that rely on learning-based mechanisms, including exposure-based treatment, may be ineffective until adequate nutritive state is restored, and timing of exposure interventions (e.g., during rapid weight restoration in a hospital setting versus weight maintenance in outpatient care) warrants future investigation. Further, behaviors that resemble anxiety-driven avoidance may be attributable to the stereotyped effects of semi-starvation that occur in all starving people, or related to habit-based, obsessional behavior secondary to weight loss. Therefore, eating rituals (e.g., eating slowly, playing with food) that are often a target of exposure-based treatment in EDs may constitute sequelae of starvation that resolve with proper nutritional rehabilitation (Essayli & Vitousek, 2020). The effects of starvation warrant consideration in the selection and timing of exposure-based treatments for individuals with EDs, and more research is needed to understand the degree to which exposure-based treatments are effective in early phases of treatment among malnourished individuals.

Additional emotions relevant to ED symptoms.

In addition to features that may be unique to EDs, some barriers to exposure implementation and efficacy may be shared between EDs and ADs. For example, while fear is commonly identified as a core emotion related to the development and maintenance of anxiety-related psychopathology, and most often targeted in exposure-based treatments for both ADs and EDs, the incorporation of additional aversive emotion states may augment treatment efficacy. For instance, emerging AD research suggests that increased focus on disgust is warranted, given evidence that this emotion functions to motivate avoidance behaviors central to anxiety and anxiety-related disorders (Olatunji et al., 2017). Similar to the AD field, research in EDs suggests that disgust is a distinct emotional state that is associated with picky eating and restrictive eating behaviors (Egolf et al., 2018), and may relate to ED symptoms in both nonclinical (Anderson et al., 2018; Davey & Chapman, 2009) and clinical samples (Bou et al., 2018). Basic research on disgust learning processes (e.g., conditioning and extinction) suggests that, once conditioned, disgust is associated with a slower rate of extinction than fear in both ADs (Olatunji et al., 2007) and EDs (Hildebrandt et al., 2015).

To date, these findings have been used to inform initial efforts to develop novel treatment approaches (Bosman et al., 2016; Olatunji et al., 2017; Plasencia et al., 2019) and should be considered to augment the efficacy of existing exposure-based treatments that may not effectively address persistent disgust-based psychopathology.

Fixed beliefs.

Another clinical feature of some EDs (and some ADs) that may negatively influence the successful implementation of exposure is firmly fixed beliefs, which may emerge during times of acute starvation and severe symptoms (Behar et al., 2018; Mehler et al., 2001). For example, body image distortion has traditionally been a hallmark of ED diagnosis, and neurobiological research confirms perceptual deficits in neural substrates related to attention and self-evaluative networks in individuals with AN (Castellini et al., 2013). Further, there is evidence of a positive genetic correlation between schizophrenia and AN (Brainstorm Consortium et al., 2018). Extreme malnutrition likely exacerbates difficulties in ‘reality testing,’ which may naturally remit with weight restoration, and, at any stage of treatment in severe EDs, paranoid thinking and obsessions surrounding preoccupation with weight and shape may create challenges to standard therapeutic exposure interventions that target anxiety. In clinical investigations of OCD, overvalued ideation (i.e., a transient psychotic feature within which the accuracy of obsessive beliefs is unquestioned) can impair emotional processing during exposure therapy (Foa & Kozak, 1986; Kozak & Foa, 1994). Additionally, impaired insight can interfere with disconfirmatory learning, sensitize individuals to feared outcomes, and reduce future approach behaviors (McKay et al., 2015). As such, the tendency of individuals with severe AN to present with pronounced overvalued ideation may preclude maximal benefit from standard exposure therapy intervention.

Heterogeneity of symptom presentation and function.

While not unique to those with EDs, it is relevant to acknowledge that heterogeneity of symptom presentation and function among those with EDs necessitates careful assessment. For example, some individuals with EDs may drink excess water in order to reduce hunger, while others present with restriction of water intake in order to avoid feelings of fullness. The recently developed Eating Disorder Fear Questionnaire (EFQ) and accompanying Eating Disorder Fear Interview (EFI) highlight the range of eating disorder fears, which include fear of food, weight gain, social consequences, personal consequences, physical sensations, social eating, and exercise-related fears, and indicate need for various exposure targets among those with EDs (Levinson, Vanzhula, et al., 2019). Identification of individual symptom function is necessary in constructing an exposure hierarchy with precision exercises that target fears relevant to each individual. Given the multitude of potential avenues for exposure in EDs, clinicians should prioritize modalities and exercises that align most closely with a given patient’s presentation (see Supplemental File 1 for two case examples). Collaborative construction of hierarchies with patients, along with significant scaffolding and debriefing exposure exercises, is particularly useful in ongoing assessment and clarification of whether exercises are appropriately engaging ED-related fears.

Clinicians' beliefs about exposure.

A final component that may impede the effective use of exposure therapy that is relevant for all disorders, and no less so in EDs, involves clinicians' negative beliefs about the treatment. Specifically, many clinicians believe that exposure therapy is intolerable for most patients and poses unacceptably high risk to patients' safety and wellbeing (Deacon et al., 2013). Previous research shows that clinicians who endorse these beliefs are prone to avoiding the use of exposure therapy altogether and delivering the treatment in a highly cautious manner, which is suboptimal for achieving clinical benefits (Deacon et al., 2013; Farrell et al., 2013). These beliefs are reportedly common among clinicians who treat EDs (Turner et al., 2014) and may account for why many clinicians "shy away" from using exposure with ED patients (Waller et al., 2012). To address this issue, a variety of training interventions have been developed to effectively address clinicians' concerns about using exposure therapy (Deacon et al., 2013; Farrell et al., 2013; Farrell et al., 2016), and these interventions appear useful when applied among ED clinicians (Waller et al., 2016).

Suggested future directions for mechanistic, translational, and clinical research

As noted above, although existing work supports common associations between risk for anxiety and EDs, and exposure therapy has received renewed interest in the literature, there remain several notable gaps in the field's understanding of anxiety and eating pathology that require further study. Below, we highlight future directions for mechanistic, translational, and clinical research that may spur discovery and improve the field's understanding of the overlap between EDs and anxiety, as well as exposure-based treatment.

Biologically-Based Mechanistic Research.

Recent research in ADs has proposed that identification of biological mechanisms of psychological treatments may result in enhanced intervention efficacy (McNally, 2007; Todd et al., 2014); in a parallel manner, increased understanding of the extent to which biological mechanisms in EDs overlap with those in ADs may facilitate improved interventions.

Further investigations are necessary to determine whether fear-related neurocircuitry and alterations in learning processes identified in ADs (Fullana et al., 2015; Pittig et al., 2018) are similarly disrupted in EDs. In addition to experiences of fear and avoidance, neurobiological research of individuals with EDs will also assist in identifying whether less-studied emotional or internal experiences (e.g., disgust, altered interoception) dominate or interact with fear for particular symptoms. In addition, further research is needed to understand how threat- and reward-based biological mechanisms interact to promote ED symptoms. While altered threat and reward processes are both implicated in EDs, little research has examined how these systems may act in concert with one another in the context of ED risk, maintenance, and treatment. Of note, research is needed that characterizes relationships between nutritional status, neuropsychological profiles, and a range of both behavioral and cognitive ED symptoms to identify the degree to which alterations in neurobiological processes persist or improve with nutritional restoration.

Translational Research.

Translational research that moves an understanding of basic science towards clinical application is also needed to improve exposure-based treatments for EDs.

Improving extinction learning.

A range of intervention agents may enhance adaptive extinction learning, and, by extension, exposure therapy. Preliminary findings from recent pilot studies in ED samples suggest that administration of neuromodulation methods (e.g., transcranial direct current stimulation; tDCS) is associated with improvements in ED, anxiety, and mood symptoms (Costanzo et al., 2017; Khedr et al., 2014), and recent developments in the AD intervention field suggest that neuromodulation (tDCS) paired with exposure protocols may enhance exposure efficacy (van ’t Wout-Frank et al., 2019). Similarly, some initial work suggests that moderate-intensity exercise may engage neurotransmitter systems that promote consolidation of extinction learning (Powers et al., 2015; Tanner et al., 2018), though this effect has not been tested among those with EDs. As these efforts are early in development, additional work is needed to examine whether specific neuromodulation methods effectively target key neurocognitive factors and neural mechanisms that would boost the effects of exposure on EDs.

Identification of relevant moderators.

In addition to improving extinction learning among those with EDs, more generally, translational research can also assist in determining whether individual differences that are captured via biobehavioral markers (e.g., performance on neurobehavioral tasks, brain imaging, genetic risk scores) may be informative in determining which patients may benefit most from exposure-based ED interventions, as neuropsychological and biological markers of risk and change have indicated some relationship to response to exposure therapy in ADs (Felmingham et al., 2013; Knuts et al., 2014; Neylan, 2017). Finally, in addition to identifying which patients may benefit most from certain exposure-based approaches, research that investigates the effects of nutritional status on behavioral learning could inform decisions about when during the course of treatment exposure-based interventions may be indicated (or contraindicated).

Clinical Research.

Direct treatment research is also of critical use to front-line clinicians and represents a third area for future study. Current cognitive and behavioral treatments for EDs do include some intervention components that align with exposure-based principles, such as challenging fears of weight gain with regular weighing and challenging food rules by identifying and purposefully ‘breaking’ these rules (Fairburn et al., 2009; Murphy et al., 2010), though there is very little direction in CBT-based treatment manuals on how to properly conduct exposure exercises in order to maximize their effect or how to intentionally engage inhibitory learning mechanisms during the therapeutic process. Further, there is little mention of how to intentionally engage inhibitory learning mechanisms during the therapeutic process, and a limited repertoire of exposure-based targets and techniques outlined in existing manuals. As process-based approaches have gained traction in other areas, updating and expanding

clinical thinking in the application of exposure-based principles to EDs is necessary (Weissman et al., 2017). While many exposure-based techniques, specifically those associated with exposure to feared foods and exposure to distressing body image cues, are also anecdotally used in intensive ED treatment settings (e.g., residential, intensive outpatient, and partial hospitalization programs), rigorous data evaluating their use across treatment settings will aid in further standardizing best practice and ensure evolution of exposure practice alongside new research evidence.

Comprehensive protocols targeting fear of weight gain.

The first pressing area for future research concerns rigorous testing of comprehensive exposure protocols that are targeted to the core symptoms of EDs. For example, while some literature has explored the effectiveness of exposure-based techniques in EDs, these studies have primarily been modular, and have focused on the application of one type of exposure therapy at a time (e.g., imaginal exposure; interoceptive exposure). Investigating a singular exposure component may not be sufficient to dismantle the panoply of eating and weight-related fears that are often present in EDs, and the specific focus of these treatment studies may be insufficient to induce clinically-significant reductions in symptoms. Given the current state of knowledge in inhibitory learning, expectancy violation, and deepening therapeutic learning, the development and rigorous testing of *comprehensive* exposure-based protocols with individualized assessment, evaluation, and treatment could provide the next step in advancing behavioral treatments for EDs. Further, clinical research on exposure-based interventions for EDs should prioritize fear of weight gain as a primary target, as recent evidence confirms that this symptom is at the center of ED symptom networks in group-based analyses, highlighting its potential to maximize downstream intervention effects (Levinson et al., 2017). In order to target fear of weight gain most effectively, a clearer understanding of how this fear develops and the range of negative consequences associated with this outcome could improve our ability to target and weaken US-CS associations. Understanding the scope and depth of what individuals believe will happen if they were to gain weight will assist in developing exposures that maximize expectancy violation that gaining weight will lead to the reported feared consequences associated with living in a larger body.

Relapse prevention and psychological recovery.

While research has primarily investigated the use of exposure therapies early in treatment, at which point issues related to optimal timing and therapeutic readiness are debated, little research has investigated the use of exposure-based strategies at later stages of ED treatment. A large portion of individuals may physically and behaviorally recover from EDs to the point where they no longer meet diagnostic criteria for an ED, but still report high levels of psychological symptoms (e.g., weight concern), and these individuals may be at greater risk for relapse (Bardone-Cone et al., 2018). Exposure-based interventions may be particularly useful for individuals who report behavioral recovery but who continue to struggle with body dissatisfaction, fear of weight gain, and social appearance anxiety. Later in recovery, bold and challenging interventions (e.g., having confederates judge individuals while wearing revealing clothing; eating a meal out in which participants are asked to eat energy-dense foods while a therapist who orders a salad and criticizes the participants' meal) may

provide maximal benefit for relapse prevention (Essayli & Vitousek, 2020; Farrell et al., 2019).

Identifying therapeutic process variables that mark progress.

Finally, in addition to generalized research on outcomes and research probing optimal timing for the delivery of exposure, future investigation should focus on characterizing therapeutic process variables relevant to the success of behavioral interventions. For instance, recent research in EDs suggests that willingness to engage with internal experiences and use of avoidance and escape behaviors can influence treatment success (Espel et al., 2016). During the course of exposure therapy, client willingness to engage with negative affect and cognitions could affect the likelihood of engaging in avoidance behavior (e.g., counting calories) during or following an exposure exercise. Characterization of exposure-based process variables (e.g., client and therapist willingness, avoidance, and escape behavior) through intensive sampling could offer a deeper understanding of in-session experiences that impact treatment outcome.

Conclusions

The current review aimed to integrate current knowledge on the overlap between anxiety and EDs from a behavioral framework, with a focus on implications of this overlap for exposure-based ED interventions. It is clear that EDs often involve experiences of anxiety and fear, and, to this end, exposure-based interventions may hold great potential to improve treatment for these often difficult-to-treat behaviors, symptoms, and disorders. Despite this potential, relevant mechanisms and clinical utility of exposure-based interventions for EDs have been understudied, showing initial promise without rigorous follow-up. Based on updated knowledge of both eating pathology and exposure, programmatic research efforts in this area are necessary. Increased understanding of fear-related mechanisms in eating pathology, from both a broad perspective as well as an ideographic level, could improve treatment recommendations and produce broader, more efficient and effective ED recovery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Eating disorders (EDs) and anxiety disorders evidence shared risk and significant comorbidity
- The current paper reviews the overlap between anxiety-based disorders and EDs
- We discuss how exposure-based strategies may be adapted for use in ED treatment.
- We outline future research directions for exposure-based therapies in EDs.

Table 1.

Anxiety-relevant eating disorder symptoms, potential behavioral treatment approaches, current evidence for these approaches, questions for future research, and clinical considerations.

Potential Behavioral Treatment Approach(es)	Current Evidence	Questions of Interest for Future Research	Clinical Considerations
Fear of Weight Gain			
• Imaginal: scripts focusing on significant and substantial (as defined by patient) weight gain • Imaginal: scripts focused on uncertain and/or volatile weight trajectory • In vivo: Graphing expected vs. actual weight trajectory week by week during treatment • In vivo: exposure to "number on the scale" via addition of unknown amounts of weight	• One case study indicated that imaginal exposme targeting fear of potential weight gain/"fatness" significantly reduced eating disorder symptoms at end of treatment and 1 month post-treatment follow-up (Levinson et al., 2014). • A 4-session trial of online imaginal exposme therapy for EDs significantly reduced ED fears and global ED symptoms at end of treatment and 6-month follow-up (Levinson et al., 2020). • While part of a larger intervention. Waller and colleagues (2020) report use of in-vivo exposme to weights and tracking of expectancy violation and have reported promising effects on eating disorder symptoms (Waller et al., 2019)	• Timing to target this fear in treatment is under debate (i.e. before vs. after weight restoration) • Exploring relative utility of exposure to current weight versus exposure to "control" over weight/weight gain	• Weight gain may be expected. Therefore, the likelihood of the feared outcome (i.e., weight gain) may not be unrealistic; challenging fear of weight gain in individuals with low weight may aim to develop distress tolerance skills and highlight new learning that "I can gain weight, and I can tolerate the distress." • Distinguish fear of weight gain itself from anticipated consequences of/associations with weight gain • Validation of actual consequences of weight gain (i.e., negative social comments), while highlighting the disproportion of the negative reaction to these consequences, or the ability to tolerate these negative reactions
Fear of Objective Fatness			
• Imaginal & virtual-reality: Heavier self • Interoceptive: Wearing clothing that increases sensed size of body • In Vivo: Engaging in weight activism activities	• A non-dieting intervention among college students has shown to reduce anti-fat attitudes (Wilson et al., 2020) • Fear of objective fatness also targeted in Levinson et al., 2014 and Levinson et al., 2020 (see Fear of Wight Gain)	• Increased investigation of imaginal and virtual-reality based exposures related to fear or fatness	• Validation of societal forces reinforcing fear of fatness (i.e., stigma towards higher weight bodies), while highlighting the disproportion of the negative reaction to these consequences, ability to tolerate negative reactions, or incompatibility of these societal pressmes and personally held values
Fear of Fullness			
• Interoceptive: water loading, lie on left side; wearing tight clothing across stomach. Induce fullness and sit with/ focus on internal sensations (e.g., feeling full, GI activity) and anxiety related to lack of empty stomach	• Acceptance-based interoceptive exposme for ARFID includes exposures to unpleasant visceral sensations (Zucker et al., 2019). • Gulping water and wearing tight clothing are endorsed as feared behaviors in some individuals with EDs and has been used initial case-series trials of exposme for EDs (Boswell et al., 2019). • After an overnight fast, individuals with AN drank significantly less water than healthy individuals but reported greater increases in negative affect and greater fullness post-water loading. Lower water intake was associated with greater visceral hypersensitivity, anxiety sensitivity, negative affect, body vigilance, pre-task feelings of fullness, feeling fat, fear of gaining weight/becoming fat, clothing feeling tight on the stomach, and urges to restrict, body check, and weigh oneself (Brown et al., 2020).	• Currently unclear the degree to which fear of fullness operates independently from fear of fat or weight gain	• Some patients may drink excessive water as an ED behavior to mimic fullness in order to reduce hunger. Water loading would not be appropriate for these individuals. • The amount of water should not be excessive (e.g. < 1.5 liters), and such exposme should not be conducted in populations at risk for hyponatremia or seizmes. Medical clearance is essential prior to engaging in these exposures. • Assess and identify whether patients endorse fears of gastric distension and fullness separate from food. • Hunger and fullness cues may vary with nutritional status, dietary restriction, and binge eating symptoms, and may not be nonnative for several months. • Some EDs (e.g., ARFID) can include fear of negative consequences of fullness such as vomiting, independent of shape and weight concerns
Gastric Sensitivity (Nausea; Discomfort)			

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Potential Behavioral Treatment Approach(es)	Current Evidence	Questions of Interest for Future Research	Clinical Considerations
• In vivo: smell rotten things; spinning, reading while spinning; 'disgusting' foods	• Acceptance-based interoceptive exposure for ARFID includes exposures to unpleasant visceral sensations (Zucker et al., 2019). • A recent case study of acceptance-based interoceptive exposure included milkshake ingestion to build tolerance to aversive physical sensations associated with disgust (Plasencia et al., 2019). • A clinical case series of interoceptive exposure for EDs included spinning in a chair to induce nausea (Boswell et al., 2019) • Emetophobia exposure exercises include spinning (Hunter & Antony, 2009).	• Investigation of whether heightened gastric sensitivity is related to elevations in fear, disgust, or other affective states.	• Some EDs (e.g., ARFID) include increased sensory sensitivity. • Assessment of this gastric sensitivity should include a comprehensive medical assessment to rule out GI-related abnormalities. • Individuals who are malnourished and/or underweight may experience increased dizziness at baseline; medical clearance and procurement of a safe environment is recommended. • If disgust if the primary emotion driving gastric sensitivity, knowledge of differential extinction for disgust versus fear and proposed disgust-centric exposure [e.g., OCD (Knowles et al., 2018)] is recommended
Intolerance of Uncertainty			
• Imaginal: uncertain outcomes • In vivo: soot weighing; meal exposure involving unknown calorie content, amount of food, type of food; surprise exposures in other domains	• A non-clinical sample of women ($N = 85$) were randomized to groups where knowledge of the contents of chocolate consumed (i.e., IU) was experimentally manipulated. Results suggest both trait and state IU may be important clinical targets (Kesby et al., 2019).	• Currently unclear whether intolerance is greater for uncertainty or uncontrollability among individuals with EDs (Haynos et al., 2020). Future research would benefit from differentiating expected uncertainty (e.g., the potential for unclear outcomes is known) versus unexpected uncertainty (e.g., the potential for unclear outcomes is a surprise)	•Increased uncertainty may motivate/increase urge to engage in safety behaviors, due to elevated perception of potential or unknown threat; therefore, successful exposures will likely require therapeutic intervention to identify and interrupt/prevent related safety behavior
Perfectionism			
• In vivo: purposefully making mistakes; practicing routines or normal activities without perfectionism-based safety behaviors	• A group treatment for perfectionism was evaluated across settings (inpatient, PHP, outpatient) that includes use of a perfection-oriented exposure hierarchy. In addition to demonstrating feasibility, the intervention led to decreases in high standards (C. A. Levinson et al., 2017)	• Perfectionism can be broken into different facets, including evaluative concern and high personal standards. More research is needed to determine which aspects of perfectionism may warrant intervention, and if different facets of perfectionism necessitate different interventions (Haynos et al., 2018)	• Achievement orientation can augment striving for therapeutic gains in treatment (i.e., success at recovery); therefore, certain facets of perfectionism may be a useful tool for a clinician in other domains
Body Checking			
• In vivo: Wearing clothing that provokes discomfort without checking self, wearing clothing a size too small in a social situation; not wearing makeup • Self-monitoring: Tracking urges to body check	• Females high in body dissatisfaction ($N = 22$) were randomized to exposure conditions that were "negative" (asked to engage in body checking of disliked body parts) or "positive" (asked to engage in body checking of self-defined attractive body parts). Those in the "negative" condition demonstrated significantly greater increases in the perceived attractiveness of loathed body parts and decreased avoidance behavior over time compared to those in the "positive" condition (Jansen et al., 2016).	• Improved understanding of both the immediate and delayed impact of in vivo, experimentally induced body checking is necessary in order to better understand its function, and develop and improve interventions aimed at reducing this behavior	• As it does not provide immediate relief, body checking may serve alternate functions in the context of eating pathology than typical safety behaviors • Body checking often occurs below the level of awareness, which may increase difficulty in identifying its presence, and in intervening in a timely manner • Inducing critical body checking as an in vivo exposure may serve to reduce cognitive and affective response over time.
Body Image Avoidance			

Potential Behavioral Treatment Approach(es)	Current Evidence	Questions of Interest for Future Research	Clinical Considerations
• In vivo: Mirror exposure: wearing revealing clothing in social situations, during mirror exposures • Interoceptive: body-related mindfulness	• Mirror exposure exercises reduce body dissatisfaction ((Delinsky & Wilson, 2006; Griffen et al., 2018). • Both pure (unguided) and guided mirror exposure have demonstrated reductions in body image avoidance	• Unclear whether mirror exposure that involves nonjudgmental vs. positive prompts is superior (if disgust-based, then positive may be more appropriate counterconditioning) • Severity of interoceptive and perceptual distortions should be examined as potential moderators of outcome • Unclear when during treatment that body image exposure exercises may be most beneficial	• Body avoidance is strongly associated with body dissatisfaction; body dissatisfaction is one of the most pernicious symptoms in transdiagnostic eating disorders, and one of the last to subside in the context of treatment (Tomba et al., 2019)
Food Avoidance (Specific Foods)			
• In vivo: meal and food exposures • Chaining: add onto already consumed feared food (e.g., adding pepperoni to feared cheese pizza)	• Feared-food-specific EXRP protocols have been associated with greater caloric intake (Steinglass et al., 2012; Steinglass et al., 2014) and obsessive-compulsive ED symptoms among individuals with AN (Glasofer et al., 2016).	• Research that monitors therapeutic process variables (therapist and client willingness, avoidance, and escape (safety behaviors)) may assist in identifying therapeutic engagement and response	• Cognitive or behavioral avoidance/safety behaviors may undermine learning and enhance fear • Introduction of feared foods during weight restoration may perpetuate expectation that these foods lead to weight gain
Eating-related Rituals			
• Exposure and resopnse prevention (EXRP): removal of rituals during meals			• Exposures should be conducted in multiple settings/ contexts to address potential context-specific conditioning processes
Compulsive Weighing			
• Environmental manipulation: removal of scale access • Restriction of weighing to specific days and times of day (e.g., session)		• The structure (blind vs. unblind) and utility of in-session weights may be dismantled empirically.	• Distinguish for patient, the importance of regular weighing in the context of treatment vs. compulsively alone
Compulsive Exercise			
• Environmental manipulation: removal of exercise tracking devices • In vivo: Exercise Cue Exposure • Exposure and response prevention: engage in low levels of exercise to promote exposure to urges to continue and counter urges	• A program specifically designed to target compulsive exercise in patients with eating disorders includes graded exposures with response management. A recent pilot trial ($N = 32$) demonstrated initial feasibility and acceptability (Dittmer et al., 2018).	• The extent to which exercise is positively vs. negatively reinforcing in the context of EDs, and the degree to which this varies across patients, is currently unclear	• Exercise may serve very specific and idiographic functions in the context of eating pathology, which should be carefully assessed prior to intervening • Athlete identity/sport participation may both positively and negatively impact response to intervention • For some patients (e.g., elite athletes), strategic return to exercise may increase motivation for recovery
Binge Eating			
• In vivo: Binge Cue Exposure	• Early EXRP protocols targeting anxiety and negative affective responses to feared or avoided "binge" foods demonstrated mixed findings (Leitenberg et al., 1984; Leitenberg & Rosen, 1989; Martinez-Mallén et al., 2007; Schmidt & Marks, 1989; Toro et al., 2003), with evidence that EXRP is associated with greater reductions in eating disorder		

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Potential Behavioral Treatment Approach(es)	Current Evidence	Questions of Interest for Future Research	Clinical Considerations
	symptoms at 3- and 5-year follow-up (Carter et al., 2003; McIntosh et al., 2011).		
Purging (Laxative Use; Vomiting)			
• In vivo: Purge Cue Exposure • Interoceutive: Induce fullness and sit with/focus on internal sensations (e.g., feeling full, GI activity, throat tightening)	• Initial evaluations of EXRP for vomiting suggest that EXRP for vomiting in BN may be associated with reductions in urge to vomit among individuals with BN (Schmidt & Marks, 1989).		• Ensure that participant does not engage in alternate weight loss/compensatory behaviors (e.g., excessive exercise) in response to blocked availability of purging
Dietary Restriction/Fasting			
• In vivo: meal exposure with known caloric intake; sit with anxiety related to caloric consumption; scheduling eating at regular intervals			• Increased use of intermittent fasting within the larger social context may complicate planned exposure • May require patient to have reached a point where he/she is no longer engaging in other compensatory behaviors and will adhere to meal plan prior to and following the exposure
Calorie Counting			
• In vivo: eatine in situations where caloric content is unknown • Uncertainty: exposure to facts regarding lack of precision in traditional calorie information			• Calorie content is posted in many public spaces • Individuals may engage in a mental tallying and approximation of calories as a safety behavior
Social Appearance Anxiety/ Fear of Negative Appearance Evaluation			
• In vivo: wearing revealing clothing in social situations; being judged based on appearance by therapy confederates; therapist or other confederate commenting on body in the context of another type of exposure	• Among those with body dysmorphic symptoms, those instructed to decrease safety behaviors (e.g. reduce instances of concealing appearance) for 1 week showed less reactivity to in-vivo appearance-related task compare with those instructed to increase safety behaviors (Summers & Cougle, 2018)	• While anecdotally incorporated into exposure-based interventions for EDs at multiple levels of treatment, little guidance is currently available on how and when to incorporate exposures for social appearance anxiety.	• With weight restoration for those who had been underweight, comments from innocent bystanders (e.g., “you look so much healthier”) will augment planned exposures
Fear of Eating in Social Situations			
• In vivo: eatine with friends, family, at restaurants, alone at a restaurant; eating out with therapist and ordering filing food while therapist makes judgmental comments, comments about dieting			• For individuals whose fears include strangers watching them eat, it may be a realistic observation that strangers direct more attention to them while eating – particularly if the individual has specific rituals or specific eating processes that are outside the norm of routine mealtime behavior patterns • In vivo exposures that involve commenting on the client’s food require clear and thorough rationale and debriefing to ensure that the client is clear that the therapist is not actually judging intake.

Table 2.

Comorbidity rates and conceptual overlap between eating disorders and anxiety-related disorders.

Anxiety-related Disorder	Comorbidity Rates Among those with EDs	Conceptual and/or Symptom Overlap
Specific Phobia	• Up to 32 % of individuals across EDs (Bulik et al., 1997; Godart et al., 2000; Hudson et al., 2007; Ulfvebrand et al., 2015).	• Intense or irrational fears of fatness/weight gain (American Psychiatric Association, 2013) • Pervasive avoidance of food and shape- or weight-related stimuli (e.g., scales; viewing their body) (Pallister & Waller, 2008).
Generalized Anxiety Disorder	• 7-37% in AN (Bulik et al., 1997; Godart et al., 2000; Hudson et al., 2007; Lilenfeld et al., 1998; Ulfvebrand et al., 2015) • 10-55% in BN (Bulik et al., 1997; Hudson et al., 2007; Schwalberg et al., 1992; Ulfvebrand et al., 2015), • over 10% in BED (Hudson et al., 2007).	• Repetitive negative thinking processes, including both worry and rumination, are common in both AN and BN, and the content of this worry may be both general and specific to ED symptoms (Kathryn E Smith et al., 2018; Startup et al., 2013; Sternheim et al., 2012). • Worry predicts EDs longitudinally (Sala et al., 2019; Sala et al., 2018; Sala & Levinson, 2016) • Symptoms of GAD at age 10 may be more predictive of EDs in adolescence than other anxiety-based symptoms (Schaumberg et al., 2018). • Elevated intolerance of uncertainty, positive beliefs about worry, negative problem orientation, and cognitive avoidance are present in clinical and subclinical ED samples; however, comprehensive tests regarding the fit of various GAD models to ED samples have yet to be conducted (Konstantellou et al., 2011; Rawal et al., 2010).
Obsessive Compulsive Disorder	• 33-50% of individuals with EDs (Kaye et al., 2004; Thiel et al., 1995)	• Significant shared genetic risk between AN and OCD (Yilmaz et al., 2018). • Individuals with EDs may have intrusive thoughts about losing control over eating and intrusive images of themselves as fat (Belloch et al., 2016; Garcia-Soriano et al., 2014), with the frequency and emotional disturbance of these cognitions comparable to obsessions in OCD. • Thought-shape fusion, the belief that thinking about or imaging the act of eating a “forbidden” food contributes to weight gain and/or is indicative of moral wrongdoing (Shafran et al., 1999). • Compulsions and repetitive behaviors in EDs aimed at preventing feared weight gain (e.g., compulsive exercising (Meyer et al., 2011), body checking (Mountford et al., 2006), mealtime rituals (Gianini et al., 2015). • Distinct types of obsessive thoughts (e.g., gaining weight uncontrollably; fear of losing control over eating) are predictive of specific behavioral responses (e.g., body checking) and vice-versa (Bailey & Waller, 2017; Levinson, Sala, et al., 2018),
Panic Disorder	• 3-34% of those with EDs and higher than rates observed in the general population (Godart et al., 2000; Hudson et al., 2007).	• Heightened interoceptive awareness (T. A. Brown et al., 2017; Jenkinson et al., 2018), sensitivity (Klabunde et al., 2013; Pollatos et al., 2008), and processing (Berner et al., 2017; Oberndorfer et al., 2013; Strigo et al., 2013) • Gastrointestinal complaints (e.g., early satiety, fullness, bloating, constipation (Sato & Fukudo, 2015)) • Hypersensitivity to, and difficulty tolerating, aversive body sensations are associated with severity of ED symptoms (T. A. Brown et al., 2017). • Elevated anxiety sensitivity (Anestis, Holm-Denoma, et al., 2008; Fulton et al., 2012; Thompson-Brenner et al., 2018). • Attempts to avoid internal experiences and/or difficulty tolerating physical sensations (e.g., gastric sensations) may play a role in ED risk and maintenance (Boyd et al., 2005; Brand-Gothelf et al., 2016; T. A. Brown et al., 2017; Zucker et al., 2013).
Social Anxiety Disorder	• 17-34%, which is greater than rates in the general population (12.1%) (Brewerton et al., 1995; Ruscio et al., 2008).	• BN predicts later onset of SAD (Buckner et al., 2010); EDs and SAD may result from shared vulnerabilities, including social appearance anxiety (the fear of social judgment specifically on one’s appearance) and maladaptive perfectionism (Levinson & Rodebaugh, 2012; Levinson et al., 2013) • Social anxiety commonly presents in individuals with EDs, especially in situations regarding potential social judgment related to appearance and eating in social settings (e.g., restaurants, shopping malls, cafeterias)(Gutiérrez-Maldonado et al., 2010). • Co-occurring symptoms that ‘bridge’ or connect between SAD and EDs include eating in public and feeling nervous about one’s appearance (Levinson, Brosof, et al., 2018; Levinson et al., 2014; Levinson, Zerwas, et al., 2018)
Posttraumatic Stress Disorder	• lifetime PTSD diagnoses among those with EDs range from 12% among individuals with AN, 26% of those with BED, and 45% of those with BN (Hudson et al., 2007)	• Tramna exposure is considered a non-specific risk factor for EDs, with childhood and sexual trauma representing particularly salient risk factors (Smolak & Murnen, 2002; Wonderlich et al., 2001). • Individuals with PTSD and EDs often report emotion dysregulation (Ehring & Quack, 2010; Lavender et al., 2015) and alexithymia, or difficulty identifying emotional experiences (Frewen et al., 2008; Westwood et al., 2017). • ED behaviors, particularly binge eating and purging, may serve a function of numbing or escaping from PTSD symptoms (Mitchell & Wolf, 2016), with a recent cross-sectional network analysis of comorbid PTSD and ED symptoms supporting associations among irritability and binge eating (Vanzhula et al., 2019)

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Anxiety-related Disorder	Comorbidity Rates Among those with EDs	Conceptual and/or Symptom Overlap
		• Sexual trauma, in particular, may influence one's body image (Dansky et al., 1997; Sack et al., 2010) and contribute to a desire to appear less attractive or hide one's body (which could instigate either weight gain or loss).