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REVIEW AND SYNTHESIS

Biophobia: A Hidden Dimension of Human-Nature Relationships

A review of the phenomenology, aetiology and treatment of animal phobia and insights for biophobia

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Abstract

1. Biophobia refers to a fear of living things, which leads to alienation from nature. The literature examining the underlying mechanisms and treatment of biophobia is sparse.
2. This review aims to increase the readers' understanding of biophobia by examining the more extensive literature on specific phobias, namely animal phobia, as it most closely resembles biophobia.
3. Fear, anxiety and disgust play an important role in specific phobias. Their triggers and functions are reviewed in the context of animal phobia.
4. Theoretical models for specific phobias suggest that phobias develop because genetically linked behavioural patterns interact with normal development fears and environmental factors. Phobias are then maintained by cognitive and behavioural mechanisms.
5. Exposure therapy, the gold standard treatment for specific phobia, functions to override the maladaptive stimulus–stimulus and stimulus-response associations responsible for animal and other specific phobias. Its delivery and efficacy are reviewed.
6. We recommend that readers interested in biophobia use the existing knowledge on animal phobia and specific phobia in general to treat biophobia and generate research hypotheses for future study.

KEYWORDS
anxiety, biophobia, disgust, exposure therapy, fear, specific phobia

Domestic animals (cats, dogs), rodents (rats, mice), reptiles (snakes, lizards) and certain invertebrates (spiders, cockroaches) induce emotional reactions in most individuals, but for 4%–9% of the population, they induce clinically significant fear that is inconsistent with the actual level of danger present (Eaton et al., 2018). These fears typically start in childhood and persist into adulthood for many individuals (Ajdacic-Gross et al., 2016; Wardenaar et al., 2017). The sounds, movements, and physical appearance of these animals are loathed and confrontation elicits thoughts of impending doom from either being attacked or from panicking (Arntz et al., 1993; McNally & Steketee, 1985). These aversive thoughts and distress are accompanied by escape and avoidant behaviour that negatively impacts people's relationships and ability to function at school, work, or at home (American Psychiatric Association, 2013). Although not a

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recognised Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; American Psychiatric Association, 2013) disorder, the term biophobia, which is defined as the fear of living things (Simaika & Samways, 2010), encapsulates the animal type of specific phobia. However, as biophobia also involves an alienation from nature (Simaika & Samways, 2010; Soga et al., 2020), it appears to be a broader construct than animal phobia. Although individuals who meet diagnostic criteria for an animal phobia may go to great lengths to avoid the feared animal, avoidance may not always involve a withdrawal from nature. Given the growing, but sparse research on biophobia, the aim of this review is to increase the reader's knowledge about biophobia's potential underlying mechanisms and best treatment choice by examining the more extensive literature on animal phobias.

1 | PHENOMENOLOGY: ANXIETY, FEAR AND DISGUST

All animal phobias involve fear and anxiety. Predatory imminence theory portrays a continuum from anxiety, to fear, to panic that represents the biobehavioural response that occurs as a predator increases in spatiotemporal proximity to the prey (Perusini & Fanselow, 2015). Anxiety is the anticipation of a fear-inducing stimulus and occurs when a predator is more distal in time and space. It is an aversive state and serves to increase behaviours that are likely to minimise contact with a predator. Fear-related responses occur when the predator is imminent, but not actively predating. In rodents this might include freezing or flattening of the body to allow stealthy creeping away from the predator. Finally, panic is the response that ensues when the predator actively attacks. Prey may bite, spit or enlarge themselves (e.g. piloerection)—all of which serve to ward off an attack. These reactions to predators offer a useful guide for thinking about the behavioural components of animal phobic responses in humans.

In humans, anxiety and fear involve evaluative judgements about distress, physiological arousal and behavioural avoidance (Lang, 1979). Evaluative judgements refer to the subjective and conscious feelings that people experience when threatened and include verbal reports of anxiety and fear, an elevated perception of risk, and associated complaints about worry and distractibility (Hengen & Alpers, 2019; Lang & Cuthbert, 1984). The physiological component of anxiety and fear can consist of tachycardia, blood pressure elevation, sweating, muscle tension, startle and changes in facial expressions (e.g. raised eyebrows and upper eyelids; Gray, 1971; Lang et al., 2000). Behavioural avoidance includes an entire defence cascade ranging from flight or fight, immobility and collapse (Kozlowska et al., 2015). These three components can vary in intensity and be concordant (e.g. high arousal, high distress and active avoidance) or discordant (e.g. low arousal, high distress, passive avoidance; Lang, 1977).

To explain why subjective emotional experiences do not always correlate or co-occur with behavioural and physiological responses, LeDoux and Pine (2016) developed a two-system framework. This framework posits that cortical circuits control conscious feeling states (e.g. fear, anxiety) and that subcortical circuits, mostly non-consciously, control defensive reactions (e.g. freezing, flight, physiological responses) and actions to threats (e.g. escape, avoidance). According to this framework, the amygdala and the bed nucleus of the stria terminalis are responsible for detecting and responding to threats. When a threat is immediately present, connections from the lateral nucleus to the central nucleus of the amygdala are presumed to control defensive reactions, and connections from the lateral nucleus to the basal nucleus of the amygdala, and then to the nucleus accumbens are presumed to control defensive actions. When a threat is far-off or uncertain, defensive reactions are thought to be controlled by connections from the hippocampus and lateral nucleus to the basal nucleus of the amygdala, and then to the bed nucleus of the stria terminalis. From there, connections to the ventral striatum are thought to control defensive actions. The framework then posits that activation of the amygdala and the bed nucleus of the stria terminalis indirectly contribute to subjective experiences of fear and anxiety by generating responses (e.g. brain and body arousal) that modulate other circuits spread across the lateral and medial cortex that are directly responsible for conscious experience. In this manner, subjective experiences of fear and anxiety are thought to differ from nonemotional states only in terms of requiring a greater level of input into the cortical circuits (LeDoux & Pine, 2016).

In addition to fear and anxiety, disgust may also be present in animal phobias. Disgust is physiologically distinct from fear and anxiety, with a decelerating heart rate and a distinct facial expression composed of eye narrowing, nasal wrinkling, a gaping mouth and an uncomfortable queasy feeling in the stomach (i.e. nausea; Stark et al., 2005). Animals that have particular features, notably a wet or glistening appearance (e.g. reptiles), a tube-like or spider-like body form (e.g. worms, snakes, spiders) or certain patterns of movement (e.g. scuttling, slithering) are likely to trigger disgust (Stevenson et al., 2019). Disgust also can be elicited by animal behaviours, such as eating habits (e.g. coprophagy), defecation, and sexual behaviour (Muris, van der Heiden, et al., 2008) and can arise through disease associations and country or culture-specific knowledge (e.g. that dogs carry rabies—relevant in some countries; or that dogs are regarded by one's religion as unclean—in other countries), from public health messaging (e.g. bats are a carrier of the Hendra virus), or from one's parents (e.g. rats are *dirty* and carry *disease*). In the same way that anxiety shares key features with fear, disgust appears to have an anticipatory form (Stevenson et al., 2019). Moreover, thinking about a disgusting animal and/or its disgusting features may bring about anxiety (Rachman, 2004) and contribute to avoidance (Stevenson et al., 2019). This connection between disgust and anxiety/fear may be due to animal characteristics that are perceived to facilitate unwanted contact (de Jong & Borg, 2020; Oaten et al., 2009).

In sum, all animal phobias involve fear and anxiety, and some animal phobias will also involve disgust. Small animals may initially elicit disgust because of their disease-associated characteristics, whereas other animals may initially trigger anxiety and fear because

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of their prototypical predator characteristics. Animals that initially elicit disgust may then trigger anxiety and fear, and all three aversive emotional states may or may not occur in tandem with defensive reactions and actions.

2 | AETIOLOGY: THEORETICAL MODELS FOR ANIMAL PHOBIA

Because of noted differences in who is most likely to experience a phobia and what is most likely to be feared, some scholars have proposed that animal phobias are innate, having been hard-wired through evolution. Females are three times more likely to experience an animal phobia than males (Wardenaar et al., 2017). Historically, it would have been advantageous for women to exhibit caution towards snakes and spiders to protect their offspring, whereas avoiding animals would have hindered men's ability to hunt (Rakison, 2009). Similarly, biological preparedness accounts have been used to explain why some fears appear to be more common than others (e.g. snakes vs. clowns). According to preparedness theory, stimuli that presented a survival threat in our evolutionary past (e.g. spiders, snakes, heights, fire and thunder) are more readily conditioned into fears and phobias and are more difficult to extinguish than other stimuli (Seligman, 1971). Although early studies appeared to support preparedness theory, closer examination of these studies and later studies indicate that fears and phobias encompassing biologically significant stimuli are not more rapidly acquired or more resistant to extinction than other stimuli (Åhs et al., 2018; Coelho et al., 2019; Shapouri & Martin, 2022). Overall, it seems more likely that evolution has predisposed us to learn about threat rather than specific stimuli (Åhs et al., 2018).

The multifactorial model has the most empirical support for explaining the aetiology and maintenance of animal phobias. The multifactorial model posits that specific phobias develop because genetically linked behavioural patterns and discrete learning experiences interact with normal developmental fears (Muris & Merckelbach, 2001, 2012). Children experience a variety of fears during development, and only those children with genetic vulnerability factors that influence the evaluation of stimuli and who also experience distinct learning experiences that exacerbate normal childhood fears are presumed to develop a specific phobia (Muris & Merckelbach, 2001, 2012). These genetic and environmental factors can be common to all phobias or unique to each phobia or individual (Taylor, 1998; Van Houtem et al., 2013). The existing data suggest that specific phobias, including animal phobias, are mostly the result of general genetic factors and specific environmental influences (Loken et al., 2014; Van Houtem et al., 2013). Genetics seems to account for 32%–45% of the variability in susceptibility to animal phobias and fears, whereas unique environmental factors explain between 53% and 71% of the variance (Van Houtem et al., 2013). As sex differences have not been found for genetic contributions (Van Houtem et al., 2013), the higher prevalence of animal phobias in females is likely due unique environmental influences, such as being treated differently because of one's sex or gender due to cultural expectations for men to be brave and for women to avoid threats.

Behavioural inhibition, a general genetic factor, is a temperament style characterised by strong negative reactions (e.g. freezing, extreme distress, withdrawal) in novel situations and is inherited by about 10%–15% of children (Kagan et al., 1984). Research has shown that behaviourally inhibited children are more likely to develop an anxiety disorder, including a specific phobia, compared to uninhibited children (Biederman et al., 1990, 1993; Dyson et al., 2011; Paulus et al., 2015). Behavioural inhibition might help to explain why urbanisation is positively correlated with perceived danger and fear towards invertebrates (Soga et al., 2020). Individuals living in urbanised environments, who have reduced access to natural habitats and limited opportunities to learn about different invertebrates, may react with fear and attempt to avoid and escape these stimuli due to their novelty (Zsido et al., 2022). Thus, when urbanised, behaviourally inhibited individuals encounter these unusual animals, they may display more fear and withdrawal than behaviourally uninhibited individuals. To date, research has not examined this pathway.

In addition to behavioural inhibition, disgust sensitivity may confer further risk for misperceiving danger. Disgust sensitivity is at least partially inherited and refers to the degree to which an individual experiences disgust in response to certain stimuli (Sherlock et al., 2016). Theoretically, there are two reasons disgust sensitivity may play a role in the aetiology of animal phobia and biophobia. First, the primary function of disgust is to facilitate avoidance from diseased and contaminated stimuli—of which many animals (e.g. spiders, cockroaches, worms) confer temporally or spatially (Davey, 1991; Matchett & Davey, 1991). Second, and akin to behavioural inhibition, disgust sensitivity may moderate the relationship between urbanisation and the development of biophobia. Individuals from urbanised environments, who are highly sensitive to disgust, may avoid natural environments and small animals more readily than individuals low in disgust sensitivity. In support of this assumption, research has shown that disgust sensitive students are less interested in touching and exploring organic substances and environments (Bixler & Floyd, 1999). Moreover, studies have shown that individuals who meet diagnostic criteria for an animal phobia report more disgust sensitivity than nonphobic individuals (de Jong et al., 1997; Merckelbach et al., 1993; Tolin et al., 1997) and that more intense disgust sensitivity is related to greater phobic symptoms (Muris, van der Heiden, et al., 2008). Recently, Rádlová et al. (2020) showed that nonfearful participants rated fear and disgust-eliciting snakes as high on only their respective emotions, whereas snake fearful participants rated disgust-eliciting snakes as fearful and disgusting and fear-eliciting snakes as disgusting and fearful. In fact, high fearful participants were unable to distinguish between fear-eliciting (e.g. viper) and disgust-eliciting snakes (e.g. blind snake). These data support the view that disgust sensitivity may play a role in the acquisition and maintenance of animal phobias.

The multifactorial model also posits that environmental influences, such as associative learning, contribute to the development

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of phobias. Associative learning involves the formation of associations among concrete or abstract (e.g. time, context) stimuli and/or responses and is usually subdivided into Pavlovian conditioning and instrumental conditioning (Pearce & Bouton, 2001). Pavlovian conditioning occurs when a neutral stimulus (e.g. a spider) is associated with an unconditional response (e.g. fear) through repeated pairings with an unconditional stimulus (e.g. being bitten by a spider). Once a neutral stimulus begins to predict the occurrence of an unconditional response, it becomes capable of eliciting a conditional response (e.g. fear) and is no longer neutral (i.e. now a conditional stimulus). When the unconditional response is strong, only one pairing of the neutral stimulus with the unconditional stimulus may be needed to trigger future conditional responses (Haesen et al., 2017; Rachman, 1977). Thus, individuals can develop a conditional fear response after only one aversive experience.

Individuals can also indirectly learn that a stimulus predicts an aversive outcome (i.e. unconditional response), such as by watching it happen to someone else (vicarious learning) and modelling anxious behaviours or by being told a stimulus is dangerous (negative information transmission; Rachman, 1977). Both modelling and negative information transfer are thought to result from associative learning. For example, a child may learn to be afraid of a stimulus (e.g. spiders predict fear) by observing the conditional response of a parent when they confront the stimulus (Gerull & Rapee, 2002; Rachman, 1977). In the case of negative information transfer, a child may learn to associate a previously neutral stimulus (e.g. spiders) with an aversive outcome (e.g. fear; unconditional response) through repeated verbal pairings of the conditional stimulus (e.g. 'be careful outside', 'do not play in the garden', 'do not touch that', 'that is dirty', 'avoid spiders') and the conditional response (e.g. disgust, fear, or anxiety; Murray & Foote, 1979; Olatunji & Viar-Paxton, 2020; Rachman, 1977). Consequently, conditional responses can be acquired directly and indirectly via associative learning.

Other environmental influences that can contribute to the development of a specific phobia include stressful life events and daily hassles not related to the feared event (e.g. parental divorce, death in the family; Asselmann & Beesdo-Baum, 2015; Coelho et al., 2020) and overprotective, intrusive and controlling parenting styles (Raknes et al., 2017; Rapee et al., 2009; Wood et al., 2003). Magee (1999) argues that aversive life events may create an environment of threat and an expectation of harm which children generalise to relatively harmless objects (e.g. dogs) or situations (e.g. the dark). Conversely, Spence and Dadds (1996) postulate that negative life events exacerbate behavioural responses that fuel phobias (e.g. behavioural inhibition) and/or buffer the effects of factors that reduce the occurrence of phobias (e.g. helpful coping strategies). Regarding parental rearing behaviours, Milliner et al. (2013) posits that overprotective parents model fearful behaviour in response to threat-related stimuli, frequently intervene to protect their child from perceived harm, and accommodate their child's unnecessary avoidant behaviour, all of which reinforce the potential threat associated with a stimulus. To date, research has supported the assumption that parental modelling and reinforcement of anxious behaviour is associated with problematic levels of childhood anxiety later on (Fisak & Grills-Taquechel, 2007).

Once a feared association is learned via conditioning processes, instrumental learning then maintains the fear (Muris & Merckelbach, 2001, 2012). According to Mowrer (1960), when individuals escape or avoid a conditional fear stimulus, they experience an immediate reduction in anxiety, which then negatively reinforces avoidance behaviour. As a result, the next time they encounter the conditional stimulus, they will be more likely to negatively react and respond with avoidance (Mowrer, 1960). This repetitive avoidance prevents the individual from learning that a feared stimulus is not harmful, and reinforces false beliefs that avoidant behaviour prevents negative outcomes (Mowrer, 1960). Research has not fully supported Mowrer's (1960) theory. Fear is not always needed to motivate avoidance and avoidant behaviour can be acquired purely through Pavlovian conditioning (Krypotos et al., 2015). Nevertheless, research has shown that avoidant behaviour can become a habit through repetition and that even subtle avoidance maintains threat beliefs (Arnaudova et al., 2017).

Information processing biases may also maintain fear, such as attentional bias and interpretation bias. In the case of fear, an attentional bias is the tendency to prioritise and allocate attention to threatening information over neutral or positive information, whereas an interpretation bias is the tendency to appraise ambiguous situations as negative or threatening (White et al., 2011). Research has demonstrated that anxious children and adolescents show a negative interpretation bias and that this bias tends to be stronger when the content being examined matches participants' anxiety subtype (e.g. animal scenarios/animal phobia; Stuijfzand et al., 2018; Subar et al., 2022). Although research on attentional bias has demonstrated that individuals with elevated trait anxiety preferentially allocate attention to threat cues and/or have difficulty disengaging from them, other research has shown that some people exhibit attentional avoidance or no attentional bias (McNally, 2019). Further complicating matters is the low internal consistency and test–retest reliability of the measures used to detect an attentional bias (MacLeod et al., 2019; McNally, 2019). Currently, it remains unclear whether the inability to detect stable attentional biases to threat across time, stimuli, tasks, and settings is due to poor task psychometric properties, a dynamic process that changes over time, or different factors moderating attention (e.g. mood state, threat intensity and content matching; MacLeod et al., 2019).

Another cognitive bias relevant to animal phobias is expectancy bias. Two common forms include overestimation of the likelihood of a threat (i.e. overestimation of probability) and overestimation of the severity of a threat (i.e. overestimation of cost). Studies have found that highly fearful and phobic individuals tend to overestimate the likelihood of encountering a feared stimulus or aversive outcome (e.g. being bitten or being contaminated by a spider; Aue & Hoeppli, 2012; de Jong et al., 1997; de Jong & Peters, 2007) and exaggerate the potential harm that could result from such an encounter (e.g. pain will be unbearable, last forever, or arm will have be amputated; Arntz et al., 1993; Di Nardo

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et al., 1988; Hengen & Alpers, 2019). Although Davey (1991) originally posited that fear expectancies for large and small animals differ, in that small animal fears are outside of one's awareness or limited to disgust (e.g. the animal will contaminate me) and that large animal fears are associated with predatory beliefs (e.g. the animal will attack me), later research has identified that this may not be the case. For example, both spider and dog phobic participants have reported a range of harm, attack and predator beliefs as well as concerns about becoming panicky, losing control and dying as a result of contact with their feared stimulus (Arntz et al., 1993; Byrne et al., 2016; Hengen & Alpers, 2019; Oar et al., 2016). Overall, research demonstrates that animal phobias can include overestimations about both fear and disgust outcomes, perhaps as a function of an animal's characteristics, and that disgust expectancies can induce greater fear expectancies (de Jong & Borg, 2020; Lipsitz et al., 2002; Muris, Mayer, et al., 2008; Oaten et al., 2009; Zvaríková et al., 2021).

Foa and Kozak (1986) suggest that overestimation of probability and cost expectancies causes a heightened state of anxiety and fear that leads to the development of maladaptive coping mechanisms, such as avoidant behaviour, that reduce exposure to the feared object/situation. Avoidance prevents the individual from engaging in activities that would help them to learn that their feared event is unlikely to happen or is not as detrimental as imagined, which then reinforces cognitive biases (Foa & Kozak, 1986). In support of these assumptions, research has shown that threat overestimations are correlated with fear levels and avoidant behaviour and that avoidance maintains threat expectancies (Lovibond et al., 2008, 2009; Olatunji et al., 2008; van Overveld et al., 2006).

Taken together, it appears that specific phobias are characterised by fear and disgust reactions that are out of proportion to the actual danger present. These marked and persistent emotional responses develop due to multiple factors, including genetics, neurobiology, negative life events, Pavlovian conditioning, modelling of fear, and negative information transfer, and are subsequently maintained by cognitive biases and behavioural mechanisms.

3 | THE ORIGINS OF EXPOSURE THERAPY

As a result of viewing phobias as learned conditions, researchers began exploring whether phobias could be unlearned by exposing individuals to their feared stimuli in the absence of harm or injury. This work led to the development of exposure therapy, which is considered the treatment of choice for animal phobias. Exposure therapy aims to help people overcome the maladaptive conditional stimulus-unconditional stimulus associations and the maladaptive conditional stimulus-conditional response associations assumed to be responsible for their irritational and debilitating fear. Over the years, exposure therapy has been delivered in slightly different ways to match the level of existing knowledge on the underpinnings of maladaptive anxiety and phobic responses as well as our knowledge about how exposure therapy works.

Early on, systematic desensitisation was used (Wolpe, 1961). This exposure-based treatment required the client to confront their feared stimuli, in a graduated fashion, in the presence of a nonanxiety-producing stimulus. In practice, this consisted of (1) teaching clients progressive muscle relaxation techniques to induce deep relaxation; (2) generating fear hierarchies that included low anxiety-inducing situations up to high anxiety-inducing situations; and (3) then asking patients to imagine their feared situations while interspersing relaxation so that they remained calm throughout the session (Wolpe, 1961). Clients repeatedly imagined situations lower on the fear hierarchy until the scene no longer provoked anxiety. At that point, the next most anxiety-inducing situation was confronted, and the process was repeated until the final, most anxiety-producing situation on the fear hierarchy ceased to produce anxiety. This graduated approach resulted in situations higher on the hierarchy provoking less anxiety than if they had been confronted at the beginning of therapy. Situations on the fear hierarchy were generally presented for 5–15 s depending on how long clients needed to achieve a clear visualisation and situations were generally presented between 8 and 30 times during a session. If patients were amenable, therapists used hypnosis to facilitate visualisation and relaxation during systematic desensitisation.

Wolpe (1968) posited that reciprocal inhibition was responsible for systematic desensitisation's positive outcomes. He believed that progressive muscle relaxation inhibited anxiety by producing a physiologically incompatible relaxation response. However, a handful of experimental trials showed that contiguous relaxation increased arousal (Borkovec & Sides, 1979; Wolpe & Flood, 1970) and did not always improve exposure outcomes (Agras et al., 1971; Dawson & McMurray, 1978; McGlynn, 1973; Waters et al., 1972). The data seemed to indicate that when relaxation facilitated outcomes it was because it enhanced the vividness of clients' imagined scenes (Borkovec & Sides, 1979; Mathews, 1971). As some individuals naturally have vivid imaginations (Lang et al., 1970; Weerts & Lang, 1978) and may not require the relaxation add-on, systematic desensitisation and reciprocal inhibition came into disrepute.

Flooding therapy became popular when studies accumulated showing that prolonged in vivo exposure produced better outcomes than imaginal exposure (Emmelkamp & Wessels, 1975; Mathews, 1978). In clinical practice, flooding involved exposure to high intensity stimuli for prolonged periods. Sometimes a semi-graded exposure approach was used, in which clients were presented with more threatening scenes across sessions, but in a less finely graded manner than was done with systematic desensitisation (James, 1986). Whether using a graduated approach or not, clients were encouraged to confront their phobic situations until their anxiety reactions diminished significantly. To facilitate this approach, fear hierarchies included subjective unit of distress ratings (Wolpe, 1973). Each stimulus on the hierarchy was assigned a rating based on how much anxiety the client presumed the stimulus would elicit (e.g. 0 to 100, with 0 indicating no distress and 100 indicating the most distress). Flooding sessions generally continued until a decrement in distress ratings was reported. Although in vivo exposure

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was commonly recommended, some researchers advocated for the use of prolonged imaginal exposure (Chambless et al., 1982; Foa et al., 1980; James, 1986).

Habituation and extinction theories were used to explain the benefits of flooding therapy. Both habituation and extinction theories suggested that repeated, nonreinforced exposure to phobic stimuli (i.e. conditional stimulus–no unconditional stimulus) was enough to produce a decrease in anxiety and fear. Extinction was viewed as the process in which conditioned emotional and behavioural responses become extinguished over the course of repeated, nonreinforced conditioned stimulus presentations (Marks, 1973; Rescorla & Wagner, 1972). Habituation, on the other hand, was viewed as the observable conditional response decrement over the course of repeated, nonreinforced conditioned stimulus presentations (Lader & Mathews, 1968; Mathews, 1971; Thompson & Spencer, 1966).

4 | CONTEMPORARY EXPOSURE THERAPY

As a result of noticing that client appraisals changed once they felt at ease during extinction-based treatments, researchers began to incorporate cognitive processes into their treatment mechanism theories (Marshall, 1985). Bandura (1977) posited that therapy strengthens self-efficacy, which then encourages individuals to engage in coping behaviour and reduce avoidance. Lang (1977) speculated that imagery processing was responsible for behaviour change, such that nonreinforced exposure to stimuli that evoke both stimulus and response elements of a stored prototype fear image modifies the affective nature of that image. Foa and Kozak (1986) elaborated on this perspective by suggesting that fear is represented in memory structures that contain information about the dangerousness of stimuli and/or their responses and about the physiological activity required to escape the threat. They asserted that exposure therapy activates and modifies these fear structures through exposure to and integration of fear-relevant information that is incompatible with the fear memory. Such emotional processing is assumed to be represented by three indicators. First, increased physiological responding at initial conditional stimulus presentation indicates that the fear memory has been evoked by matching information (fear activation). Second, decreased physiological responding during a single session of repeated, unreinforced exposure to feared stimuli indicates that response elements have dissociated from stimulus elements in the fear structure and that corrective information is being integrated (within-session habituation). Third, decreased physiological responding across sessions, even when increasingly more difficult stimuli are confronted, indicates that general beliefs and attitudes about one's ability to cope with feared situations has occurred (between-session habituation). These propositions became the foundation for modern exposure therapy.

Öst (1989) then developed a one-session treatment for specific phobias to improve the efficiency and cost-effectiveness of exposure therapy. Once a thorough behavioural analysis has been done to understand the client's phobic behaviour and the client is deemed suitable for the treatment, treatment proceeds over the course of 3 h. The treatment consists of psychoeducation, modelling, and prolonged exposure to multiple feared stimuli (Öst, 1989; Öst et al., 1991). Psychoeducation instructs the client as to how they have reinforced and maintained their phobia through avoidance and escape behaviour and further explains that to change their unhelpful beliefs and reduce their anxiety that they must confront their feared stimuli. The therapist then models exposure, reinforces client exposure, and requests that the client expose themself to more and more fearful situations, whereas the client commits to remaining in each exposure activity until their anxiety fades.

Modelling is used to encourage the client to work through their fear hierarchy. It involves the therapist describing and then demonstrating how to engage in an exposure activity. After witnessing how the therapist interacts with the feared stimulus, the client then does the same thing; first when the therapist is in the room and then again when the therapist is out of the room. The therapist verbally (and when working with children, physically) reinforces the client for their engagement with the feared stimulus. Before ending one exposure activity and moving onto the next most confronting situation, a client's anxiety should drop by at least 50% (Öst et al., 2001). Once anxiety levels drop, the therapist asks the client to reflect on the nonoccurrence of the feared consequence and to draw conclusions about their catastrophic beliefs.

This process repeats itself with an exposure activity that requires closer contact with the feared stimulus and continues until the client can interact with the stimulus without exerting control over the situation. For example, the client might start by touching the cage of a spider, then move onto touching the spider with a paintbrush, then putting a gloved hand into the cage, then touching the spider with a bare finger, then allowing the spider to walk on a bare hand, and then finally allowing the spider to crawl all over their body. This final step provides an opportunity for overlearning, so that the patient can confidently engage in everyday behaviour (e.g. gardening, walking in a park, sleeping in a bed a night) without being disturbed by the stimulus (Öst, 1989). After completion of the final step, the process starts over with a new, more feared stimulus (e.g. a larger spider). After all planned stimuli have been confronted with minimal anxiety, the session ends and the client is asked to continue carrying out exposure activities in their everyday life to maintain and generalise their changed beliefs to new situations.

Unfortunately, not everyone who receives exposure therapy benefits and some who benefit experience relapse (Arch & Craske, 2009; Vervliet et al., 2013). Sometimes initial fear activation and within- and between-session habituation are correlated with positive outcomes, and sometimes not (Craske et al., 2008). Although extensive methodological differences likely contribute to the varied findings, research also suggests that the mixed findings may be due to the nature of inhibitory learning. Rather than erase the original conditional stimulus–unconditional stimulus association, unreinforced conditional stimulus presentations may create a new,

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inhibitory association (conditional stimulus–no unconditional stimulus association; Craske et al., 2014; Todd et al., 2014). Therefore, after exposure therapy, a conditional stimulus will signal both the nonavailability of the unconditional stimulus (i.e. the new inhibitory conditional stimulus–no unconditional stimulus association) and the occurrence of the conditional stimulus (i.e. the original excitatory conditional stimulus–unconditional stimulus association). These two memories will compete for retrieval after exposure therapy. Fortunately, experimental and theoretical research has suggested a number of ways to strengthen the inhibitory association and prevent the retrieval of the excitatory association, thereby facilitating initial outcomes and preventing relapse.

The Rescorla Wagner model (1972) posits that extinction learning occurs when there is a mismatch between what an individual thinks will occur and what actually occurs. Greater expectancy violations result in stronger inhibitory learning (Craske et al., 2014) and better treatment outcomes (Hilleke et al., 2021). Therefore, clients should participate in exposure activities designed to maximally violate their CS-US expectancies. For a specific phobia, this means exposures will need to be in vivo because the client will need to believe that their feared outcomes can occur. It also means that safety signals and safety behaviours need to be removed. Safety signals are stimuli that indicate the conditional stimulus is safe (e.g. a parent for a child), whereas safety behaviours are overt or covert actions done to avoid distress and/or prevent the unconditional stimulus from occurring when exposed to the conditional stimulus (e.g. wearing gloves when touching a spider). If safety signals and safety behaviours are available during exposure activities, clients may inadvertently learn that the unconditional stimulus did not occur solely because of their presence (Telch & Lancaster, 2012). Clients may only be willing to engage in exposures that maximally violate expectancies after they have completed easier exposures that build up their self-efficacy. Therefore, if clients are unwilling to immediately drop safety signals and safety behaviours, therapists should structure the fear hierarchy so that it gradually weans clients from these avoidance tactics. Essentially, a balance needs to be struck between maximising what a client can learn from an exposure activity and what they are willing to do at any given point in time.

Regardless of the intensity of the exposure activity, therapists should ask clients to predict and clearly articulate what will happen from the activity. Expected outcomes should include the anticipated unconditional stimulus and its cost. After the exposure activity is completed, clients should reflect on whether these outcomes occurred (Craske et al., 2014). Because exposure activities are designed to violate expectancies, predicted outcomes rarely occur, and when they do, they are almost never as bad as expected. For example, a cockroach may crawl on a client and trigger anxiety, but the anxiety does not kill the client or land them in a psychiatric hospital due to a never-ending panic attack. To learn from exposure activities, clients must notice the conditional stimulus and the nonoccurrence of the unconditional stimulus (Craske et al., 2014). If they try to divert their attention away from the exposure activity, the therapist should redirect their focus to the conditional stimulus and its outcomes (or lack therefore) and/or use more salient stimuli.

Another method that can be used to fully violate expectancies and improve inhibitory learning is to incorporate a variety of feared stimuli (e.g. Huntsman spider, St Andrews Cross spider, orb-weaving spider) and stimuli that predict their occurrence (e.g. bushes, rocks) into treatment (Craske et al., 2014). In the first instance, exposure activities should involve just one feared stimulus, and then later be conducted with multiple stimuli together (Craske et al., 2014). This process of 'deepened extinction' may augment expectancy violation and strengthen the inhibitory association by extinguishing, restoring and then reviolating the conditional stimulus–unconditional stimulus expectation (Rescorla, 2006). Clients also may benefit from working through the fear hierarchy haphazardly rather than linearly. The unpredictability of exposure activities better mimics real life and may facilitate fear toleration because it teaches clients that they can manage when they are not in control (Craske et al., 2014; Norberg et al., 2018).

Research has demonstrated that inhibitory associations are context dependent, meaning they are best retrieved in the contexts in which they were learned (Bouton, 2004). Therefore, clients should engage with their feared stimuli in multiple real-life contexts (Vansteenwegen et al., 2007). Varying context requires exposures to be conducted in different locations, at different times of the day, during different times of the year and with varying interoceptive levels (e.g. hungry vs. not hungry, stressed vs. not stressed).

Given that it is difficult to conduct exposure activities in all contexts, retrieval cues can be used to retrieve the inhibitory association in new contexts after treatment has ceased. Retrieval cues are extra stimuli presented in short durations during exposure activities that become associated with the inhibitory association (Brooks & Bouton, 1994). A slightly different approach may include taking photos or videos of the exposure activity and then looking at these photos and videos in new contexts to retrieve the inhibitory association. The reinstatement brought on by a physical cue may create a bridge between contexts and reduce the return of fear (Mystkowski et al., 2006).

Another strategy to enhance accessibility of the inhibitory association may be to occasionally reinforce the presentation of a conditional stimulus with the unconditional stimulus (Craske et al., 2014). For a child who experiences a dog phobia, this could involve playing with a puppy that bites. The occasional biting in the context of not being attacked should teach the child that in the context of reinforced trials, nonreinforced trials will follow (e.g. puppy biting does not lead to an aggressive attack). Importantly, it may also help to show individuals that they can cope with the unconditional stimulus, and that the cost of the outcome is not as severe as presumed, which also helps to violate expectancies.

Scheduling exposure sessions with progressively longer intervals in between each other may also enhance expectancy violation (Craske et al., 2014). As time passes, the conditional stimulus–unconditional response association will be more likely to retrieved than the inhibitory association. This is known as spontaneous recovery. Therefore, expanding the duration between sessions may allow for greater expectancy violation as compared to a single massed

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exposure session. Expanding the time between sessions could also allow clients another opportunity to learn from variability, which may promote spontaneous retrieval of the inhibitory association (Bjork & Bjork, 1992) and enhance its long-term retention (Schmidt & Bjork, 1992).

Finally, inhibitory learning may be strengthened by conducting exposures during the reconsolidation period (Craske et al., 2014). When stored memories are retrieved, they are rewritten into long-term memory (Nader et al., 2000). To capitalise on this neurochemical process, brief exposure and then withdrawal of the conditional stimulus 10–30 min prior to an exposure session may weaken the conditional stimulus–unconditional stimulus memory through incorporation of new information (Craske et al., 2014; Kredlow et al., 2016).

Despite years of theoretical conjecture, we continue to not know exactly how exposure therapy works or which method of treatment delivery reliably improves treatment outcomes. As a result, numerous (slight) variations on the treatment have been and continue to be delivered. Benito et al. (2018) found that positive exposure therapy outcomes were associated with within-session fear reductions only when they seemed to occur from direct internal actions (i.e. not as a result of safety signals, rituals, distraction, accommodation, avoidance or escape). Moreover, Pittig et al. (2023) demonstrated that while exposure therapy effectively violates expectancies for threat occurrence (i.e. shows clients that predicted outcomes do not occur after exposure activities) and reduces threat occurrence expectancies (i.e. clients believe that if they repeat the exposure activity, that their feared outcomes will beless likely to occur than they initially presumed), only change in expectancies (not violation) predicted symptom reduction. They also demonstrated that expectancy violations do not always result in congruent expectancy changes. For example, a client may believe that if they stand next to a spider that it will 100% attack them. After standing next to a spider during an exposure activity, they may report that an attack did not occur (0%; expectancy violation). However, when asked how likely the spider will attack them if they stand next to it again, they may say it is 85% likely to occur (expectancy change). These combined findings indicate that the mechanism underlying successful exposure therapy may be habituation that occurs because of inhibitory learning and that inhibitory learning is not instantaneous or guaranteed. First, inhibitory learning cannot occur if threat expectancies are not identified pre-exposure. Therapists and clients must be trained to define testable beliefs and observable feared outcomes. Second, expectancy violation may need to be guided and reinforced. Therapist may need to encourage clients to reflect on the nonoccurrence of the threat outcome and their ability to manage any outcome that did occur, and to use this information to change their expectancies. Therapists may also need to take into account other factors that may interfere with inhibitory learning, such as years since onset of phobia, stressors, cognitive biases, avoidance behaviours and context changes, and adapt sessions and treatment length appropriately.

5 | THE EFFICACY OF EXPOSURE THERAPY

Although exposure therapy does not work for everyone, it remains the first-line treatment for specific phobia due to its superiority over other treatments (Bandelow et al., 2022). When examining 33 treatment studies, Wolitzky-Taylor et al. (2008) found that exposure therapy outperformed wait-list control conditions ($d = 1.05$), placebo control treatments ($d = 0.48$) and active treatment control conditions ($d = 0.44$). Results were fairly similar for self-report and behavioural measures and for posttreatment and follow-up assessments. This meta-analytic review also found that in vivo exposure outperformed other delivery modalities at posttreatment ($d = 0.38$) but not at follow-up ($d = 0.20$). Other modalities included imaginal exposure, systematic desensitisation, eye movement desensitisation and reprocessing, computer-aided vicarious exposure, and virtual reality. More treatment sessions were associated with greater superiority when exposure was compared to a wait-list control condition.

Since Wolitzky-Taylor et al. (2008) published their meta-analysis, technology has advanced and more virtual reality and augmented reality studies have been published. Despite this additional research, sufficient evidence does not yet exist to use these forms of delivery as a first-line treatment (Bandelow et al., 2022). Rather, these treatments should only be used as adjuncts to in vivo exposure therapy or when in vivo therapy is not available. Online- and mobile-based exposure interventions show similar promise, but because of the limited research and significant participant dropout from these studies, they should not be considered as a first-line treatment (Mor et al., 2021).

A recent review examined 111 treatment studies and found that several factors may influence the success of exposure therapy. Pretreatment facilitators include being highly motivated, having high self-efficacy, high cortisol levels, and low trait anxiety (Böhnlein et al., 2020). Treatment facilitators include disgust evocation, highlighting cognitive changes, and conducting treatment in multiple contexts. Posttreatment facilitators include sleeping shortly after an exposure session. Therefore, the efficacy of exposure treatment could be enhanced by modifying factors before, during and after treatment.

6 | CONCLUSIONS AND RECOMMENDATIONS

We hope that this review on animal phobia has provided those interested in biophobia with a wealth of knowledge regarding its potential underlying mechanisms and how best to help individuals overcome their fear of living things and avoidance of nature. Points worthy of repeating include acknowledging the relevance of disgust, in addition to fear to anxiety, and considering that these subjective emotional states may or may not co-occur with their physiological and behavioural indicators. What emotions

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people feel is likely due to the nature of stimuli involved. Stimuli with disease-associated characteristics will trigger disgust, anxiety and fear, whereas only anxiety and fear may be triggered by stimuli with predator-only characteristics (though not necessarily so). Experiencing disgust, anxiety and fear are a part of life, these emotions serve to protect us. However, individuals with certain genetic characteristics (e.g. behavioural inhibition and disgust sensitivity) and who have experienced a threat either directly, vicariously or verbally, may go on to develop a life-long phobia if not treated. Stressful events, daily hassles and overprotective, intrusive or controlling parenting styles may facilitate the development of a phobia. Prioritising and allocating attention to threatening information and appraising ambiguous information as threatening may also increase the chance of developing a phobia and maintaining it, as threats will be more salient, making it easier to learn and reinforce fear associations. Overestimating the likelihood and cost of threats also seems to play a big role in maintaining a phobia. Exposure therapy aims to reduce these overestimations, as well as weaken the learned fear association. The delivery of exposure therapy likely greatly matters. Addressing all the factors known to maintain a phobia through exposure techniques, as well as psychoeducation and skills training (e.g. teaching parents how to reduce accommodation or be less controlling), is needed. By examining the history of exposure therapy, as detailed in this review, therapists can glean an idea of what has and has not worked and use this information to guide treatment for biophobia. We hope that these points have also sparked fruitful ideas for further research as we recognise and value the importance of people interacting with and caring for nature and our ecosystems.

AUTHOR CONTRIBUTIONS

Richard J. Stevenson wrote the first draft of the phenomenology section, Shanara Visvalingam and Supreet Saluja wrote the first draft of the aetiology section, Melissa M. Norberg wrote the first draft of the exposure therapy and conclusions sections. Melissa M. Norberg edited all sections. All authors approved the final version.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

We will not be archiving data because this manuscript is a narrative review and did not use data.

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REFERENCES

Agras, W. S., Leitenberg, H., Barlow, D. H., Curtis, N.-A., Edwards, J., & Wright, D. (1971). Relaxation in systematic desensitization. *Archives of General Psychiatry*, *25*(6), 511–514. https://doi.org/10.1001/archpsyc.1971.01750180031005

Åhs, F., Rosén, J., Kastrati, G., Fredrikson, M., Agren, T., & Lundström, J. N. (2018). Biological preparedness and resistance to extinction of skin conductance responses conditioned to fear relevant animal pictures: A systematic review. *Neuroscience & Biobehavioral Reviews*, *95*, 430–437. https://doi.org/10.1016/j.neubiorev.2018.10.017

Ajdacic-Gross, V., Rodgers, S., Müller, M., Hengartner, M. P., Aleksandrowicz, A., Kawohl, W., Heekeren, K., Rössler, W., Angst, J., Castelao, E., Vandeleur, C., & Preisig, M. (2016). Pure animal phobia is more specific than other specific phobias: Epidemiological evidence from the Zurich study, the ZInEP and the PsyCoLaus. *European Archives of Psychiatry and Clinical Neuroscience*, *266*(6), 567–577. https://doi.org/10.1007/s00406-016-0687-4

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

Arch, J. J., & Craske, M. G. (2009). First-line treatment: A critical appraisal of cognitive behavioral therapy developments and alternatives. *The Psychiatric Clinics of North America*, *32*(3), 525–547. https://doi.org/10.1016/j.psc.2009.05.001

Arnaudova, I., Kindt, M., Fanselow, M., & Beckers, T. (2017). Pathways towards the proliferation of avoidance in anxiety and implications for treatment. *Behaviour Research and Therapy*, *96*, 3–13. https://doi.org/10.1016/j.brat.2017.04.004

Arntz, A., Lavy, E., Van den Berg, G., & Van Rijsoort, S. (1993). Negative beliefs of spider phobics: A psychometric evaluation of the spider phobia beliefs questionnaire. *Advances in Behaviour Research and Therapy*, *15*, 257–277. https://doi.org/10.1016/0146-6402(93)90012-Q

Asselmann, E., & Beesdo-Baum, K. (2015). Predictors of the course of anxiety disorders in adolescents and young adults. *Current Psychiatry Reports*, *17*(2), 7. https://doi.org/10.1007/s11920-014-0543-z

Aue, T., & Hoeppli, M.-E. (2012). Evidence for an encounter expectancy bias in fear of spiders. *Cognition and Emotion*, *26*(4), 727–736. https://doi.org/10.1080/02699931.2011.602241

Bandelow, B., Werner, A. M., Kopp, I., Rudolf, S., Wiltink, J., & Beutel, M. E. (2022). The German guidelines for the treatment of anxiety disorders: First revision. *European Archives of Psychiatry and Clinical Neuroscience*, *272*(4), 571–582. https://doi.org/10.1007/s00406-021-01324-1

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1037//0033-295x.84.2.191

Benito, K. G., Machan, J., Freeman, J. B., Garcia, A. M., Walther, M., Frank, H., Wellen, B., Stewart, E., Edmunds, J., Kemp, J., Sapyta, J., & Franklin, M. (2018). Measuring fear change within exposures: Functionally-defined habituation predicts outcome in three randomized controlled trials for pediatric OCD. *Journal of Consulting and Clinical Psychology*, *86*(7), 615–630. https://doi.org/10.1037/ccp0000315

Biederman, J., Rosenbaum, J. F., Bolduc-murphy, E. A., Faraone, S. V., Chaloff, J., Hirshfeld, D. R., & Kagan, J. (1993). A 3-year follow-up of children with and without behavioral inhibition. *Journal of the American Academy of Child & Adolescent Psychiatry*, *32*(4), 814–821. https://doi.org/10.1097/00004583-199307000-00016

Biederman, J., Rosenbaum, J. F., Hirshfeld, D. R., Faraone, S. V., Bolduc, E. A., Gersten, M., Meminger, S. R., Kagan, J., Snidman, N., & Reznick, J. S. (1990). Psychiatric correlates of behavioral inhibition in young children of parents with and without psychiatric disorders. *Archives of General Psychiatry*, *47*(1), 21–26. https://doi.org/10.1001/archpsyc.1990.01810130023004

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Bixler, R., & Floyd, M. F. (1999). Hands on or hands off? Disgust sensitivity and preference for environmental education activities. *The Journal of Environmental Education*, *30*, 4–11. https://doi.org/10.1080/00958969909601871

Bjork, R. A., & Bjork, E. L. (1992). A new theory of disuse and an old theory of stimulus fluctuation. In W. K. Estes (Ed.), *Vol. 1: From learning theory to connectionist theory; Vol. 2: From learning processes to cognitive processes* (pp. 35–67). Lawrence Erlbaum Associates, Inc.

Böhnlein, J., Altegoer, L., Muck, N. K., Roesmann, K., Redlich, R., Dannlowski, U., & Leehr, E. J. (2020). Factors influencing the success of exposure therapy for specific phobia: A systematic review. *Neuroscience and Biobehavioral Reviews*, *108*, 796–820. https://doi.org/10.1016/j.neubiorev.2019.12.009

Borkovec, T. D., & Sides, J. K. (1979). The contribution of relaxation and expectancy to fear reduction via graded, imaginal exposure to feared stimuli. *Behaviour Research and Therapy*, *17*(6), 529–540. https://doi.org/10.1016/0005-7967(79)90096-2

Bouton, M. E. (2004). Context and behavioral processes in extinction. *Learning & Memory*, *11*(5), 485–494. https://doi.org/10.1101/lm.78804

Brooks, D. C., & Bouton, M. E. (1994). A retrieval cue for extinction attenuates response recovery (renewal) caused by a return to the conditioning context. *Journal of Experimental Psychology: Animal Behavior Processes*, *20*, 366–379. https://doi.org/10.1037/0097-7403.20.4.366

Byrne, S. P., Rapee, R. M., Malhi, G. S., Sweller, N., & Hudson, J. (2016). An examination of harm beliefs in dog fearful children. *Journal of Experimental Psychopathology*, *7*(2), 153–159. https://doi.org/10.5127/jep.048015

Chambless, D. L., Foa, E. B., Groves, G. A., & Goldstein, A. J. (1982). Exposure and communications training in the treatment of agoraphobia. *Behaviour Research and Therapy*, *20*(3), 219–231. https://doi.org/10.1016/0005-7967(82)90140-1

Coelho, C. M., Gonçalves-Bradley, D., & Zsido, A. N. (2020). Who worries about specific phobias?—A population-based study of risk factors. *Journal of Psychiatric Research*, *126*, 67–72. https://doi.org/10.1016/j.jpsychires.2020.05.001

Coelho, C. M., Suttiwan, P., Faiz, A. M., Ferreira-Santos, F., & Zsido, A. N. (2019). Are humans prepared to detect, fear, and avoid snakes? The mismatch between laboratory and ecological evidence. *Frontiers in Psychology*, *10*, 2094. https://doi.org/10.3389/fpsyg.2019.02094

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*(1), 5–27. https://doi.org/10.1016/j.brat.2007.10.003

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. https://doi.org/10.1016/j.brat.2014.04.006

Davey, G. C. L. (1991). Characteristics of individuals with fear of spiders. *Anxiety Research*, *4*(4), 299–314. https://doi.org/10.1080/08917779208248798

Dawson, R. W., & McMurray, N. E. (1978). Desensitization without hierarchical presentation and concomitant relaxation. *Australian Journal of Psychology*, *30*(2), 119–132. https://doi.org/10.1080/00049537808256366

de Jong, P. J., Andrea, H., & Muris, P. (1997). Spider phobia in children: Disgust and fear before and after treatment. *Behaviour Research and Therapy*, *35*(6), 559–562. https://doi.org/10.1016/S0005-7967(97)00002-8

de Jong, P. J., & Borg, C. (2020). Disgust sensitivity. In I. J. S. Abramowitz & S. M. Blakey (Eds.), *Clinical handbook of fear and anxiety: Maintenance processes and treatment mechanisms* (pp. 81–98). American Psychological Association. https://doi.org/10.1037/0000150-005

de Jong, P. J., & Peters, M. L. (2007). Contamination vs. harm-relevant outcome expectancies and covariation bias in spider phobia. *Behaviour Research and Therapy*, *45*(6), 1271–1284. https://doi.org/10.1016/j.brat.2006.09.007

Di Nardo, P. A., Guzy, L. T., Ann Jenkins, J., Bak, R. M., Tomasi, S. F., & Copland, M. (1988). Etiology and maintenance of dog fears. *Behaviour Research and Therapy*, *26*(3), 241–244. https://doi.org/10.1016/0005-7967(88)90005-8

Dyson, M. W., Klein, D. N., Olino, T. M., Dougherty, L. R., & Durbin, C. E. (2011). Social and non-social behavioral inhibition in preschool-age children: Differential associations with parent-reports of temperament and anxiety. *Child Psychiatry and Human Development*, *42*(4), 390–405. https://doi.org/10.1007/s10578-011-0225-6

Eaton, W. W., Bienvenu, O. J., & Miloyan, B. (2018). Specific phobias. *The Lancet Psychiatry*, *5*(8), 678–686. https://doi.org/10.1016/S2215-0366(18)30169-X

Emmelkamp, P. M., & Wessels, H. (1975). Flooding in imagination vs flooding in vivo: A comparison with agoraphobics. *Behaviour Research and Therapy*, *13*(1), 7–15. https://doi.org/10.1016/0005-7967(75)90047-9

Fisak, B., & Grills-Taquechel, A. E. (2007). Parental modeling, feinforcement, and information transfer: Risk factors in the development of child anxiety? *Clinical Child and Family Psychology Review*, *10*(3), 213–231. https://doi.org/10.1007/s10567-007-0020-x

Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin*, *99*(1), 20–35.

Foa, E. B., Steketee, G., Turner, R. M., & Fischer, S. C. (1980). Effects of imaginal exposure to feared disasters in obsessive-compulsive checkers. *Behaviour Research and Therapy*, *18*(5), 449–455. https://doi.org/10.1016/0005-7967(80)90010-8

Gerull, F. C., & Rapee, R. M. (2002). Mother knows best: Effects of maternal modelling on the acquisition of fear and avoidance behaviour in toddlers. *Behaviour Research and Therapy*, *40*(3), 279–287. https://doi.org/10.1016/S0005-7967(01)00013-4

Gray, J. A. (1971). *The psychology of fear and stress*. McGraw-Hill.

Haesen, K., Beckers, T., Baeyens, F., & Vervliet, B. (2017). One-trial overshadowing: Evidence for fast specific fear learning in humans. *Behaviour Research and Therapy*, *90*, 16–24. https://doi.org/10.1016/j.brat.2016.12.001

Hengen, K. M., & Alpers, G. W. (2019). What's the risk? Fearful individuals generally overestimate negative outcomes and they dread outcomes of specific events. *Frontiers in Psychology*, *10*, 1676.

Hilleke, M., Lang, T., & Helbig-Lang, S. (2021). Match or mismatch? The impact of expected fear on experienced fear during exposure. *Clinical Psychology: Science and Practice*, *28*, 148–160. https://doi.org/10.1037/cps0000005

James, J. E. (1986). Review of the relative efficacy of imaginal and in vivo flooding in the treatment of clinical fear. *Behavioural Psychotherapy*, *14*, 183–191. https://doi.org/10.1017/S0141347300014725

Kagan, J., Reznick, J. S., Clarke, C., Snidman, N., & Garcia-Coll, C. (1984). Behavioral inhibition to the unfamiliar. *Child Development*, *55*(6), 2212–2225. https://doi.org/10.2307/1129793

Kozlowska, K., Walker, P., McLean, L., & Carrive, P. (2015). Fear and the defense cascade: Clinical implications and management. *Harvard Review of Psychiatry*, *23*(4), 263–287. https://doi.org/10.1097/HRP.0000000000000065

Kredlow, M. A., Unger, L. D., & Otto, M. W. (2016). Harnessing reconsolidation to weaken fear and appetitive memories: A meta-analysis of post-retrieval extinction effects. *Psychological Bulletin*, *142*(3), 314–336. https://doi.org/10.1037/bul0000034

Krypotos, A.-M., Effting, M., Kindt, M., & Beckers, T. (2015). Avoidance learning: A review of theoretical models and recent developments. *Frontiers in Behavioral Neuroscience*, *9*, 189. https://doi.org/10.3389/fnbeh.2015.00189

Lader, M. H., & Mathews, A. M. (1968). A physiological model of phobic anxiety and desensitization. *Behaviour Research and Therapy*, *6*(4), 411–421. https://doi.org/10.1016/0005-7967(68)90021-1

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Lang, P. J. (1977). Imagery in therapy: An information processing analysis of fear. *Behavior Therapy*, *8*(5), 862–886. https://doi.org/10.1016/S0005-7894(77)80157-3

Lang, P. J. (1979). A bio-informational theory of emotional imagery. *Psychophysiology*, *16*(6), 495–512. https://doi.org/10.1111/j.1469-8986.1979.tb01511.x

Lang, P. J., & Cuthbert, B. N. (1984). Affective information processing and the assessment of anxiety. *Journal of Behavioral Assessment*, *6*(4), 369–395. https://doi.org/10.1007/BF01321326

Lang, P. J., Davis, M., & Öhman, A. (2000). Fear and anxiety: Animal models and human cognitive psychophysiology. *Journal of Affective Disorders*, *61*(3), 137–159. https://doi.org/10.1016/S0165-0327(00)00343-8

Lang, P. J., Melamed, B. G., & Hart, J. (1970). A psychophysiological analysis of fear modification using an automated desensitization procedure. *Journal of Abnormal Psychology*, *76*(2), 220–234. https://doi.org/10.1037/h0029875

LeDoux, J. E., & Pine, D. S. (2016). Using neuroscience to help understand fear and anxiety: A two-system framework. *The American Journal of Psychiatry*, *173*(11), 1083–1093.

Lipsitz, J. D., Barlow, D. H., Mannuzza, S., Hofmann, S. G., & Fyer, A. J. (2002). Clinical features of four DSM-IV–specific phobia subtypes. *The Journal of Nervous and Mental Disease*, *190*(7), 471–478.

Loken, E. K., Hettema, J. M., Aggen, S. H., & Kendler, K. S. (2014). The structure of genetic and environmental risk factors for fears and phobias. *Psychological Medicine*, *44*(11), 2375–2384. https://doi.org/10.1017/S0033291713003012

Lovibond, P. F., Mitchell, C. J., Minard, E., Brady, A., & Menzies, R. G. (2009). Safety behaviours preserve threat beliefs: Protection from extinction of human fear conditioning by an avoidance response. *Behaviour Research and Therapy*, *47*(8), 716–720. https://doi.org/10.1016/j.brat.2009.04.013

Lovibond, P. F., Saunders, J. C., Weidemann, G., & Mitchell, C. J. (2008). Evidence for expectancy as a mediator of avoidance and anxiety in a laboratory model of human avoidance learning. *Quarterly Journal of Experimental Psychology*, *61*(8), 1199–1216. https://doi.org/10.1080/17470210701503229

MacLeod, C., Grafton, B., & Notebaert, L. (2019). Anxiety-linked attentional bias: Is it reliable? *Annual Review of Clinical Psychology*, *15*, 529–554. https://doi.org/10.1146/annurev-clinpsy-050718-095505

Magee, W. J. (1999). Effects of negative life experiences on phobia onset. *The International Journal for Research in Social and Genetic Epidemiology and Mental Health Services*, *34*, 343–351. https://doi.org/10.1007/s001270050154

Marks, I. M. (1973). Reduction of fear: Towards a unifying theory. *Canadian Journal of Psychiatry*, *18*(1), 9–12. https://doi.org/10.1177/070674377301800103

Marshall, W. L. (1985). The effects of variable exposure in flooding therapy. *Behavior Therapy*, *16*, 117–135. https://doi.org/10.1016/S0005-7894(85)80040-X

Matchett, G., & Davey, G. C. L. (1991). A test of a disease-avoidance model of animal phobias. *Behaviour Research and Therapy*, *29*(1), 91–94. https://doi.org/10.1016/S0005-7967(09)80011-9

Mathews, A. M. (1971). Psychophysiological approaches to the investigation of desensitization and related procedures. *Psychological Bulletin*, *76*(2), 73–91. https://doi.org/10.1037/h0031479

Mathews, A. M. (1978). Fear-reduction research and clinical phobias. *Psychological Bulletin*, *85*(2), 390–404.

McGlynn, F. D. (1973). Graded imagination and relaxation as components of experimental desensitization. *The Journal of Nervous and Mental Disease*, *156*(6), 377–385. https://doi.org/10.1097/00005053-197306000-00002

McNally, R. J. (2019). Attentional bias for threat: Crisis or opportunity? *Clinical Psychology Review*, *69*, 4–13. https://doi.org/10.1016/j.cpr.2018.05.005

McNally, R. J., & Steketee, G. S. (1985). The etiology and maintenance of severe animal phobias. *Behaviour Research and Therapy*, *23*, 430–435. https://doi.org/10.1016/0005-7967(85)90171-8

Merckelbach, H., de Jong, P. J., Arntz, A., & Schouten, E. (1993). The role of evaluative learning and disgust sensitivity in the etiology and treatment of spider phobia. *Advances in Behaviour Research and Therapy*, *15*(4), 243–255. https://doi.org/10.1016/0146-6402(93)90011-P

Milliner, E. L., Farrell, L. J., & Ollendick, T. H. (2013). Phobic anxiety. In *Cognitive behaviour therapy for children and families* (3rd ed., pp. 255–274). Cambridge University Press. https://doi.org/10.1017/CBO9781139344456.023

Mor, S., Grimaldos, J., Tur, C., Miguel, C., Cuijpers, P., Botella, C., & Quero, S. (2021). Internet- and mobile-based interventions for the treatment of specific phobia: A systematic review and preliminary meta-analysis. *Internet Interventions*, *26*, 100462. https://doi.org/10.1016/j.invent.2021.100462

Mowrer, O. H. (1960). *Learning theory and behavior*. John Wiley & Sons Inc. https://doi.org/10.1037/10802-000

Muris, P., Mayer, B., Huijding, J., & Konings, T. (2008). A dirty animal is a scary animal! Effects of disgust-related information on fear beliefs in children. *Behaviour Research and Therapy*, *46*(1), 137–144. https://doi.org/10.1016/j.brat.2007.09.005

Muris, P., & Merckelbach, H. (2001). The etiology of childhood specific phobia: A multifactorial model. In M. W. Vasey & M. R. Dadds (Eds.), *The developmental psychopathology of anxiety* (pp. 355–385). Oxford University Press. https://doi.org/10.1093/med:psych/9780195123630.003.0016

Muris, P., van der Heiden, S., & Rassin, E. (2008). Disgust sensitivity and psychopathological symptoms in non-clinical children. *Journal of Behavior Therapy and Experimental Psychiatry*, *39*(2), 133–146. https://doi.org/10.1016/j.jbtep.2007.02.001

Muris, P., & Merckelbach, H. (2012). Specific phobia: Phenomenology, epidemiology, and etiology. In T. E. Davis, III, T. H. Ollendick, & Ö. Lars-Göran (Eds.), *Intensive one-session treatment of specific phobias* (pp. 3–18). Springer Science + Business Media.

Murray, E. J., & Foote, F. (1979). The origins of fear of snakes. *Behaviour Research and Therapy*, *17*(5), 489–493. https://doi.org/10.1016/0005-7967(79)90065-2

Mystkowski, J. L., Craske, M. G., Echiverri, A. M., & Labus, J. S. (2006). Mental reinstatement of context and return of fear in spider-fearful participants. *Behavior Therapy*, *37*(1), 49–60. https://doi.org/10.1016/j.beth.2005.04.001

Nader, K., Schafe, G. E., & Le Doux, J. E. (2000). Fear memories require protein synthesis in the amygdala for reconsolidation after retrieval. *Nature*, *406*(6797), 722–726. https://doi.org/10.1038/35021052

Norberg, M. M., Newins, A. R., Jiang, Y., Xu, J., Forcadell, E., Alberich, C., & Deacon, B. J. (2018). The scarier the better: Maximizing exposure therapy outcomes for spider fear. *Behavioural and Cognitive Psychotherapy*, *46*(6), 754–760. https://doi.org/10.1017/S1352465818000437

Oar, E. L., Farrell, L. J., Waters, A. M., & Ollendick, T. H. (2016). Blood-injection-injury phobia and dog phobia in youth: Psychological characteristics and associated features in a clinical sample. *Behavior Therapy*, *47*(3), 312–324. https://doi.org/10.1016/j.beth.2016.01.004

Oaten, M., Stevenson, R. J., & Case, T. I. (2009). Disgust as a disease-avoidance mechanism. *Psychological Bulletin*, *135*, 303–321. https://doi.org/10.1037/a0014823

Olatunji, B. O., Cisler, J. M., Meunier, S., Connolly, K., & Lohr, J. M. (2008). Expectancy bias for fear and disgust and behavioral avoidance in spider fearful individuals. *Cognitive Therapy and Research*, *32*(3), 460–469. https://doi.org/10.1007/s10608-007-9164-8

Olatunji, B. O., & Viar-Paxton, M. (2020). Effects of "dirty" information on disgust responding to an unknown animal in children: The

25758314, 2024, 3, Downloaded from https://besjournals.onlinelibrary.wiley.com/doi/10.1002/pan3.10514 by Macquarie University, Wiley Online Library on [12/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

moderating role of maternal disgust proneness. *Behavior Therapy*, *51*(4), 634–645. https://doi.org/10.1016/j.beth.2019.10.001

Öst, L.-G. (1989). One-session treatment for specific phobias. *Behaviour Research and Therapy*, *27*(1), 1–7. https://doi.org/10.1016/0005-7967(89)90113-7

Öst, L.-G., Salkovskis, P. M., & Hellström, K. (1991). One-session therapist-directed exposure vs. self-exposure in the treatment of spider phobia. *Behavior Therapy*, *22*, 407–422. https://doi.org/10.1016/S0005-7894(05)80374-0

Öst, L.-G., Svensson, L., Hellström, K., & Lindwall, R. (2001). One-session treatment of specific phobias in youths: A randomized clinical trial. *Journal of Consulting and Clinical Psychology*, *69*(5), 814–824.

Paulus, F. W., Backes, A., Sander, C. S., Weber, M., & von Gontard, A. (2015). Anxiety disorders and behavioral inhibition in preschool children: A population-based study. *Child Psychiatry & Human Development*, *46*(1), 150–157. https://doi.org/10.1007/s10578-014-0460-8

Pearce, J. M., & Bouton, M. E. (2001). Theories of associative learning in animals. *Annual Review of Psychology*, *52*(1), 111–139. https://doi.org/10.1146/annurev.psych.52.1.111

Perusini, J. N., & Fanselow, M. S. (2015). Neurobehavioral perspectives on the distinction between fear and anxiety. *Learning & Memory*, *22*(9), 417–425. https://doi.org/10.1101/lm.039180.115

Pittig, A., Heinig, I., Goerigk, S., Richter, J., Hollandt, M., Lueken, U., Pauli, P., Deckert, J., Kircher, T., Straube, B., Neudeck, P., Koelkebeck, K., Dannlowski, U., Arolt, V., Fydrich, T., Fehm, L., Ströhle, A., Totzeck, C., Margraf, J., … Wittchen, H.-U. (2023). Change of threat expectancy as mechanism of exposure-based psychotherapy for anxiety disorders: Evidence from 8,484 exposure exercises of 605 patients. *Clinical Psychological Science*, *11*(2), 199–217. https://doi.org/10.1177/21677026221101379

Rachman, S. (1977). The conditioning theory of fear-acquisition: A critical examination. *Behaviour Research and Therapy*, *15*, 375–387. https://doi.org/10.1016/0005-7967(77)90041-9

Rachman, S. (2004). Fear of contamination. *Behaviour Research and Therapy*, *42*(11), 1227–1255. https://doi.org/10.1016/j.brat.2003.10.009

Rádlová, S., Polák, J., Janovcová, M., Sedláčková, K., Peléšková, Š., Landová, E., & Frynta, D. (2020). Emotional reaction to fear- and disgust-evoking snakes: Sensitivity and propensity in snake-fearful respondents. *Frontiers in Psychology*, *11*, 31.

Rakison, D. H. (2009). Does women's greater fear of snakes and spiders originate in infancy? *Evolution and Human Behavior*, *30*(6), 439–444. https://doi.org/10.1016/j.evolhumbehav.2009.06.002

Raknes, S., Pallesen, S., Bjaastad, J. F., Wergeland, G. J., Hoffart, A., Dyregrov, K., Håland, Å. T., & Haugland, B. S. M. (2017). Negative life events, social support, and self-efficacy in anxious adolescents. *Psychological Reports*, *120*(4), 609–626. https://doi.org/10.1177/0033294117699820

Rapee, R. M., Schneiring, C. A., & Hudson, J. L. (2009). Anxiety disorders during childhood and adolescence: Origins and treatment. *Annual Review of Clinical Psychology*, *5*, 311–341. https://doi.org/10.1146/annurev.clinpsy.032408.153628

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

Rescorla, R. A., & Wagner, A. R. (1972). A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement. In A. H. Black & W. F. Prokasy (Eds.), *Classical conditioning II: Current theory and research* (pp. 64–69). Appleton-Century-Crofts.

Schmidt, R. A., & Bjork, R. A. (1992). New conceptualizations of practice: Common principles in three paradigms suggest new concepts for training. *Psychological Science*, *3*, 207–217. https://doi.org/10.1111/j.1467-9280.1992.tb00029.x

Seligman, M. E. P. (1971). Phobias and preparedness. *Behavior Therapy*, *2*(3), 307–320. https://doi.org/10.1016/S0005-7894(71)80064-3

Shapouri, S., & Martin, L. L. (2022). Snakes vs. guns: A systematic review of comparisons between phylogenetic and ontogenetic threats. *Adaptive Human Behavior and Physiology*, *8*(2), 131–155. https://doi.org/10.1007/s40750-021-00181-5

Sherlock, J. M., Zietsch, B. P., Tybur, J. M., & Jern, P. (2016). The quantitative genetics of disgust sensitivity. *Emotion*, *16*, 43–51. https://doi.org/10.1037/emo0000101

Simaika, J. P., & Samways, M. J. (2010). Biophilia as a universal ethic for conserving biodiversity. *Conservation Biology*, *24*(3), 903–906. https://doi.org/10.1111/j.1523-1739.2010.01485.x

Soga, M., Evans, M. J., Yamanoi, T., Fukano, Y., Tsuchiya, K., Koyanagi, T. F., & Kanai, T. (2020). How can we mitigate against increasing biophobia among children during the extinction of experience? *Biological Conservation*, *242*, 108420. https://doi.org/10.1016/j.biocon.2020.108420

Spence, S. H., & Dadds, M. R. (1996). Preventing childhood anxiety disorders. *Behaviour Change*, *13*(4), 241–249. https://doi.org/10.1017/S081348390000485X

Stark, R., Walter, B., Schienle, A., & Vaitl, D. (2005). Psychophysiological correlates of disgust and disgust sensitivity. *Journal of Psychophysiology*, *19*, 50–60. https://doi.org/10.1027/0269-8803.19.1.50

Stevenson, R. J., Case, T. I., Oaten, M. J., Stafford, L., & Saluja, S. (2019). A proximal perspective on disgust. *Emotion Review*, *11*(3), 209–225. https://doi.org/10.1177/1754073919853355

Stuijfzand, S., Creswell, C., Field, A. P., Pearcey, S., & Dodd, H. (2018). Research review: Is anxiety associated with negative interpretations of ambiguity in children and adolescents? A systematic review and meta-analysis. *Journal of Child Psychology and Psychiatry*, *59*(11), 1127–1142. https://doi.org/10.1111/jcpp.12822

Subar, A. R., Humphrey, K., & Rozenman, M. (2022). Is interpretation bias for threat content specific to youth anxiety symptoms/diagnoses? A systematic review and meta-analysis. *European Child & Adolescent Psychiatry*, *31*(9), 1341–1352. https://doi.org/10.1007/s00787-021-01740-7

Taylor, S. (1998). The hierarchic structure of fears. *Behaviour Research and Therapy*, *36*(2), 205–214. https://doi.org/10.1016/S0005-7967(98)00012-6

Telch, M. J., & Lancaster, C. L. (2012). Is there room for safety behaviors in exposure therapy for anxiety disorders? In P. Neudeck & H.-U. Wittchen (Eds.), *Exposure therapy: Rethinking the model—Refining the method* (pp. 313–334). Springer Science + Business Media. https://doi.org/10.1007/978-1-4614-3342-2_18

Thompson, R. F., & Spencer, W. A. (1966). Habituation: A model phenomenon for the study of neuronal substrates of behavior. *Psychological Review*, *73*(1), 16–43. https://doi.org/10.1037/h0022681

Todd, T. P., Vurbic, D., & Bouton, M. E. (2014). Behavioral and neurobiological mechanisms of extinction in Pavlovian and instrumental learning. *Neurobiology of Learning and Memory*, *108*, 52–64. https://doi.org/10.1016/j.nlm.2013.08.012

Tolin, D. F., Lohr, J. M., Sawchuk, C. N., & Lee, T. C. (1997). Disgust and disgust sensitivity in blood-injection-injury and spider phobia. *Behaviour Research and Therapy*, *35*(10), 949–953. https://doi.org/10.1016/S0005-7967(97)00048-X

Van Houtem, C. M. H. H., Laine, M. L., Boomsma, D. I., Ligthart, L., van Wijk, A. J., & De Jongh, A. (2013). A review and meta-analysis of the heritability of specific phobia subtypes and corresponding fears. *Journal of Anxiety Disorders*, *27*(4), 379–388. https://doi.org/10.1016/j.janxdis.2013.04.007

van Overveld, M., de Jong, P. J., & Peters, M. L. (2006). Differential UCS expectancy bias in spider fearful individuals: Evidence toward an association between spiders and disgust-relevant outcomes. *Journal of Behavior Therapy and Experimental Psychiatry*, *37*(1), 60–72. https://doi.org/10.1016/j.jbtep.2005.09.007

25758314, 2024, 3, Downloaded from https://besjournals.onlinelibrary.wiley.com/doi/10.1002/pan3.10514 by Macquarie University, Wiley Online Library on [12/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Vansteenwegen, D., Vervliet, B., Iberico, C., Baeyens, F., Van den Bergh, O., & Hermans, D. (2007). The repeated confrontation with videotapes of spiders in multiple contexts attenuates renewal of fear in spider-anxious students. *Behaviour Research and Therapy*, *45*(6), 1169–1179. https://doi.org/10.1016/j.brat.2006.08.023

Vervliet, B., Craske, M. G., & Hermans, D. (2013). Fear extinction and relapse: State of the art. *Annual Review of Clinical Psychology*, *9*, 215–248. https://doi.org/10.1146/annurev-clinpsy-050212-185542

Wardenaar, K. J., Lim, C. C. W., Al-Hamzawi, A. O., Alonso, J., Andrade, L. H., Benjet, C., Bunting, B., de Girolamo, G., Demyttenaere, K., Florescu, S. E., Gureje, O., Hisateru, T., Hu, C., Huang, Y., Karam, E., Kiejna, A., Lepine, J. P., Navarro-Mateu, F., Browne, M. O., … de Jonge, P. (2017). The cross-national epidemiology of specific phobia in the world mental health surveys. *Psychological Medicine*, *47*(10), 1744–1760. https://doi.org/10.1017/S0033291717000174

Waters, W. F., McDonald, D. G., & Koresko, R. L. (1972). Psychophysiological responses during analogue systematic desensitization and non-relaxation control procedures. *Behaviour Research and Therapy*, *10*(4), 381–393. https://doi.org/10.1016/0005-7967(72)90061-7

Weerts, T. C., & Lang, P. J. (1978). Psychophysiology of fear imagery: Differences between focal phobia and social performance anxiety. *Journal of Consulting and Clinical Psychology*, *46*(5), 1157–1159. https://doi.org/10.1037//0022-006x.46.5.1157

White, L. K., Suway, J. G., Pine, D. S., Bar-Haim, Y., & Fox, N. A. (2011). Cascading effects: The influence of attention bias to threat on the interpretation of ambiguous information. *Behaviour Research and Therapy*, *49*(4), 244–251. https://doi.org/10.1016/j.brat.2011.01.004

Wolitzky-Taylor, K. B., Horowitz, J. D., Powers, M. B., & Telch, M. J. (2008). Psychological approaches in the treatment of specific phobias: A meta-analysis. *Clinical Psychology Review*, *28*(6), 1021–1037. https://doi.org/10.1016/j.cpr.2008.02.007

Wolpe, J. (1961). The systematic desensitization treatment of neuroses. *The Journal of Nervous and Mental Disease*, *132*, 189–203. https://doi.org/10.1097/00005053-196103000-00001

Wolpe, J. (1968). Psychotherapy by reciprocal inhibition. *Conditional Reflex*, *3*(4), 234–240. https://doi.org/10.1007/BF03000093

Wolpe, J. (1973). *The practice of behavior therapy* (2nd ed.). Pergamon.

Wolpe, J., & Flood, J. (1970). The effect of relaxation on the galvanic skin response to repeated phobic stimuli in ascending order. *Journal of Behavior Therapy and Experimental Psychiatry*, *1*(3), 195–200. https://doi.org/10.1016/0005-7916(70)90002-9

Wood, J. J., McLeod, B. D., Sigman, M., Hwang, W.-C., & Chu, B. C. (2003). Parenting and childhood anxiety: Theory, empirical findings, and future directions. *Journal of Child Psychology and Psychiatry*, *44*(1), 134–151. https://doi.org/10.1111/1469-7610.00106

Zsido, A. N., Coelho, C. M., & Polák, J. (2022). Nature relatedness: A protective factor for snake and spider fears and phobias. *People and Nature*, *4*(3), 669–682. https://doi.org/10.1002/pan3.10303

Zvaríková, M., Prokop, P., Zvarík, M., Ježová, Z., Medina-Jerez, W., & Fedor, P. (2021). What makes spiders frightening and disgusting to people? *Frontiers in Ecology and Evolution*, *9*, 694569. https://doi.org/10.3389/fevo.2021.694569

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