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A Contemporary Behavior Analysis of Anxiety and Avoidance

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Despite the central status of avoidance in explaining the etiology and maintenance of anxiety disorders, surprisingly little behavioral research has been conducted on human avoidance. In the present paper, first we provide a brief review of the empirical literature on avoidance. Next, we describe the implications of research on derived relational responding and the transformation of functions for a contemporary behavioral account of avoidance, before providing several illustrative research examples of laboratory-based analogues of key clinical treatment processes. Finally, we suggest some challenges and opportunities that lie ahead for behavioral research on anxiety and avoidance.

Key words: anxiety, avoidance, derived relational responding, transformation of functions, clinical behavior analysis

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Lifetime prevalence rates of anxiety disorders are estimated at between 10.6% (Sommers, Goldner, Waraich, & Hsu, 2006) and 28.8% (Kessler, Berglund, Demler, Jin, & Walters, 2005). These high prevalence rates "eclipse the capacity of specialized mental health service providers" (Sommers et al., p. 110), placing considerable demand on clinical, social, and financial resources. Unlike research on low-incidence disorders, such as autism, with which behavior analysis has had a significant and lasting impact, behavioral research on high-incidence disorders like anxiety is virtually nonexistent.

Several authors have commented on the factors that may have hampered behavior-analytic research on anxiety disorders (e.g., Eifert & Forsyth, 2007; Friman, Hayes, & Wilson, 1998). First, definitional problems with the term *anxiety* may help to explain behavior analysts' reluctance to fully pursue an experimental analysis of this topic (see Friman et al.). The etymology of the term *anxiety* shows that it has evolved from a metaphor referring to choking sensations (*anguisse*) into a pseudotechnical term with fuzzy, topography-based boundaries (Friman et al., 1998). Indeed, the ongoing expansion of the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.) (*DSM-IV-TR*; American Psychiatric Association, 2000) has created an ever-increasing number of categories and constellations of symptoms, such that *anxiety disorders* is now used as an umbrella term for a range of specific (i.e., social phobia) and nonspecific (e.g., generalized anxiety disorder) forms of anxiety. That the term *anxiety* refers to a fuzzy set of topography-based behavioral dimensions does not, however, preclude a functional analysis of the contexts that evoke use of the term (Skinner, 1945). Indeed, it may be argued that much of the existing conceptual analyses from within behavior analysis have done just that. Also, despite the inclusion of private events and topographical features in the definition of

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anxiety disorders, this does not rule out identification of the potential operant function of the behavior of anxious individuals (for a similar point made in the context of determining the function of pathological gambling, see Dixon & Johnson, 2007).

Second, Forsyth and Eifert (1996) have suggested that a possible misunderstanding over the radical behaviorist stance on private events might explain the dearth of research into human anxiety (see also Friman et al., 1998). Specifically, it is often assumed that private emotional states, such as anxiety, are not subject to rigorous behavioral analyses due to their occurrence "within the skin" (Skinner, 1974). Of course, Skinner (1945, 1974) explicitly acknowledged the existence of private events but treated them as a dependent rather than an independent variable of controlling contingencies (Hayes & Brownstein, 1987). Nevertheless, Skinner's formulation for how a successful behavioral treatment of anxiety might progress may have had the paradoxical effect of hamstringing the analysis of anxiety rather than facilitating it. That is, in the Skinnerian analysis (e.g., 1974) behavior-change efforts with anxious clients should focus on manipulable environmental conditions and should alter observable behaviors. However, Skinner also warned against the construction of theoretical accounts of private events and the use of private behavior to explain publicly observable behavior (e.g., Skinner, 1953, p. 181). In effect, Skinner acknowledged the existence of private events, but argued that they should serve merely as "middle terms" to be treated with caution. Arguably, this stance has discouraged the analysis of anxiety as a private event for its own sake (see Anderson, Hawkins, & Scotti, 1997; Dougher & Hackbert, 2000; Wilson & Hayes, 2000).

Conceptual confusion regarding the status of private events may explain, at least in part, the apparent dearth of behavioral research into human anxiety. Yet this state of affairs has occurred despite the existence of a burgeoning literature on the clinical implications of operant and respondent conditioning in humans and nonhumans. For instance, the absence of behavioral research is particularly evident in the literature on avoidance. Although many contemporary behavioral accounts emphasize the role played by avoidance in the etiology and maintenance of anxiety (Eifert & Forsyth, 2007; Hayes, Strosahl, & Wilson, 1999; Hayes, Wilson, Gifford, Follette, & Strosahl, 1996), there has been surprisingly little basic behavior-analytic research on human avoidance. Indeed, within mainstream clinical psychology and experimental psychopathology, the dominant approach to research on avoidance and anxiety is one based on cognitive and associative learning processes (e.g., Barlow, 2002; Bouton, Mineka, & Barlow, 2001; Lovibond, 2006; Mineka & Oehlberg, 2008; Mineka & Zinbarg, 2006). This cognitive-associative approach to research on avoidance and anxiety informs several modern day clinical treatments, such as exposure and response prevention, and is supported by a strong program of basic science (e.g., Bouton et al.; Mineka & Zinbarg). Despite the central status given to avoidance in explaining anxiety disorders, behavior analysts have contributed little to this research agenda; the existence of alternative, behavioral approaches to understanding anxiety is rarely acknowledged by the dominant approaches. Clearly, behavior analysts have much to do if they are to address these concerns and raise the profile of behavioral approaches to avoidance and anxiety.

Towards this end, the publication of this special issue on clinical behavior analysis, along with others, both within this journal (Vol. 16, No. 2, Fall 1993; Vol. 17, No. 2, Fall 1994) and elsewhere (e.g., Woods, Miltenberger, & Carr, 2006), is to be welcomed. These occasions are testimony to the growing interest generated by our field in understanding and treating behavior disorders such as anxiety. It is our conviction, however, that we need to demonstrate more than just a passing interest in the clinical behavior analysis of anxiety; what is now needed is a fresh empirical approach that draws on developments in the contemporary view of private (verbal) events and recent research on derived relational responding. In particular, empirical and theoretical advances in the analysis of derived relational responding have led several authors to claim that new behavioral processes may now apply in the case of complex human behavior (see Dymond, Roche, & Barnes-Holmes, 2003; Hayes, Fox, et al., 2001). If this is the case, the range of empirical questions that may now be asked and addressed by behavior analysts regarding anxiety and related avoidance processes is significantly extended. Before we outline these new developments, we will first provide a brief review of the empirical literature on avoidance. Then, we describe the implications of research on derived relational responding and the transformation of functions for a contemporary behavioral account of avoidance, before providing several illustrative research examples of laboratory-based analogues of key treatment processes. Finally, we suggest some challenges and opportunities that lie ahead for behavior-analytic research on anxiety and avoidance.

EMPIRICAL RESEARCH ON AVOIDANCE

Associative Learning

Often referred to as classical avoidance, the first theories of avoidance emerged from within the associative learning tradition. In a typical experiment with nonhumans, a warning signal (e.g., a light or tone) precedes an unconditioned stimulus (US) (e.g., electric shock) unless an avoidance response occurs. The avoidance response usually terminates the warning signal and postpones the next scheduled US presentation.

The dominant theoretical approach to explaining findings obtained in research on classical avoidance was two-factor theory, which claimed that avoidance was acquired and maintained through both respondent and operant conditioning (Bolles, 1973; Mowrer, 1947). First, respondent (Pavlovian) conditioning is involved due to the warning signal functioning as a conditioned stimulus (CS) because of its prior pairing with the US (when the avoidance response did not occur). The CS is then said to elicit fear, which is held to mediate avoidance responses that occur in its presence. Then, operant (instrumental) conditioning takes place when the organism emits the avoidance response in the presence of the CS. The avoidance response is maintained, according to two-factor theory, by escape from the CS and by an immediate reduction in its fear-eliciting properties.

Two-factor theory was highly influential during the development of the behavior therapy movement, and is considered to be an important component in the success of modern clinical interventions of exposure and response prevention. There are, however, several limitations of two-factor theory that have led to its further refinement and replacement. The first limitation concerns the empirical observation that avoidance responding may still be acquired even when responding does not terminate the warning signal but instead prevents the occurrence of future shock (Herrnstein, 1969). For two-factor theory, the absence of a reduction in the fear-eliciting properties of the warning signal should not lead to avoidance. Yet, research has consistently shown that it does (Mineka, 1979). The second limitation stems from the fact that fear responses to the warning stimulus decrease across time, such that once avoidance responding is acquired the signal ceases to elicit fear. Although this may be explained as extinction of fear, because the reliable occurrence of avoidance responding means that the warning signal is no longer followed by shock, unequivocal empirical support for this position has been lacking (e.g., Mineka; Solomon & Wynne, 1953). Although further refinements of two-factor theory have been offered (e.g., McAllister & McAllister, 1991), its main limitation is that it "relies on fear to promote avoidance responding and fear reduction to reinforce it" (Lovibond, 2006, p. 119).

From a behavior-analytic perspective, the unabashed mentalistic nature of explanations based on two-factor theory may be sufficient for some readers to dismiss it (e.g., Schoenfeld, 1950). It is important, however, to note that two-factor theory was originally intended to evade the seemingly anomalous observation that avoidance may still be acquired when the warning signal is not terminated and the only consequence of responding is the absence of the US. At the time, it was questioned whether the absence of an event could function as a reinforcer for avoidance responding (Bolles, 1973). This led to the development of a variant of two-factor theory called the safety-signal theory, which considers the absence of the US in terms of conditioned inhibition (e.g., Gray, 1975; Pavlov, 1927). It is beyond the scope of the present article to review the similarities and differences of these accounts (for reviews, see Bolles; Herrnstein, 1969; Lovibond, 2006), but the difficulties each encounters when explaining the acquisition of avoidance responding maintained by the absence of an aversive event were followed by the development of associative, cognitive, and operant accounts to do just that.

Seligman and Johnston's (1973) cognitive theory emphasized the mediational role played by expectancies in learning when to respond and when not to respond during signaled avoidance procedures. According to this account, avoidance responding is acquired through a controlled cognitive process of comparing the expected outcomes of responding and not responding; these expectancies govern learning of the operant response. Lovibond (2006) recently proposed an extension of Seligman and Johnston's theory in which Pavlovian and operant components have explicit cognitive features (Declercq, De Houwer, & Baeyens, in press; Lovibond, Saunders, Weidemann, & Mitchell, 2008; see also, Declercq & De Houwer, 2008; De Houwer, Crombez, & Baeyens, 2005). In his expectancy-based account, the warning signal comes to elicit fear through pairings with the US because participants have explicitly acquired propositional knowledge that the US will be presented following the warning signal. The learning of the operant response is based on the knowledge, or expectancy, of the relation between the avoidance response and the absence of the US. Crucially, according to this account, participants emit the avoidance response in the presence of the warning signal by comparing expectancies for the consequences of responding and not responding. In this way, "avoidance interacts with anxiety through the mediating process of expectancy of the aversive outcome" (Lovibond, p. 126).

Clinical implications. Findings from associative learning research were pivotal in the early development of behavior therapy. In fact, many of the therapeutic interventions popular today, such as exposure and response prevention, stem from this history (Barlow, 2002; Bouton et al., 2001). The effectiveness of these treatments, and the close connection with the basic research that led to their development, have led to important advances in behavior therapy (Marks, 1981; Wolpe & Rachman, 1960). This relation between clinical treatments and laboratory research on Pavlovian conditioning is well established and may be considered a representative example of a translational research agenda (Lerman, 2003).

There are several reasons, however, why treatment approaches based on associative learning processes are unlikely to account for the complexity and diversity of clinical problems. First, conditioning models necessitate a prior traumatic conditioning history with the feared object or event in order to explain the acquisition of anxiety disorders. However, many clients report no prior direct conditioning experience. To account for this, contemporary theorists have postulated vicarious or alternative routes to the acquisition of fear and anxiety (e.g., Field, 2006; Mineka & Oehlberg, 2008). Crucially, however, it is assumed that these "pathways to fear" are based on the same basic conditioning processes as direct conditioning (e.g., Bouton et al., 2001; Mineka & Oehlberg). Second, as noted by Rachman (1977, 1991), a major limitation of early conditioning models was the observation that not everyone who experienced a traumatic conditioning history developed a behavior disorder. These individual differences in the effects of conditioning are readily accommodated in contemporary accounts of conditioning (Mineka & Zinbarg, 2006) and are held as being simultaneously more complex than earlier models, yet are consistent with modern views that assert the primacy of basic conditioning processes (Bouton et al.; Field; Mineka & Zinbarg). In this way, the primacy of basic conditioning processes shared with nonhumans is preserved in order to provide a conditioning account of complex behavior disorders. Third, and often in combination with the above, several researchers have incorporated additional cognitive processes as explanatory mechanisms (Lovibond, 2006; Lovibond et al., 2008). For instance, Lovibond's expectancy model of avoidance reviewed earlier places explicit emphasis on the mediational role played by clients' expectancies, or propositional knowledge, in generating and maintaining avoidance behavior. From a behavior-analytic perspective, the primacy given to mediational constructs (e.g., expectancy) and the nonfunctional nature of the theorizing clearly do not allow sufficient precision and influence in accounting for the complexity and diversity of the clinical problems presented by anxious clients.

Overall, experimental psychopathology research based on associative learning has generated considerable basic and clinical research into anxiety and avoidance. It has grappled with the issue of the necessity of a direct traumatic conditioning experience prior to developing a behavior disorder via "pathways to fear" (Field, 2006) and other vicarious learning routes. It is beyond the scope of the present article to evaluate this literature, but it is salutary to consider, particularly in light of behavioral research on derived relational responding (see below), that human associative learning theorists are increasingly turning their attention to the role played by language or verbal processes (i.e., propositional knowledge) in generating conditioning outcomes (e.g., De Houwer, 2009; De Houwer, Vandorpe, & Beckers, 2005; Lovibond, 2006; Lovibond & Shanks, 2002). De Houwer states this position as follows:

> The core assumptions of these models are that (a) associative learning effects are based on the generation and evaluation of propositions about relations in the world and (b) that nonautomatic processes intervene in the generation and evaluation of these propositions. … Associative learning effects are driven not only by the direct experience of events. Also, prior knowledge, instructions, intervention, and deductive reasoning matter. (p. 16)

This suggests there may well be collaborative opportunities for behavior analysts and associative learning theorists in future research on anxiety and avoidance. We will return to this point in a later section.

Operant Research

In operant research, avoidance is considered to be an instance of negative reinforcement, in which behavior leads to the prevention or removal of an aversive stimulus. The role played by Pavlovian contingencies in the acquisition of avoidance responding is acknowledged by all operant accounts, but theories of avoidance, such as two-factor theory, have tended to confound two key procedural variables: deletion and postponement (Hineline, 1981). In deletion, the avoidance response removes the scheduled aversive event. In postponement, avoidance responses prevent or postpone the scheduled aversive event; in the absence of continued responding, the aversive event occurs. The majority of operant research on avoidance has employed postponement procedures with or without warning signals, and it was Sidman's (1953, 1962) demonstration of the acquisition of free-operant avoidance that provided the seminal example. Sidman arranged for brief shocks to be presented according to a fixed shock–shock (S-S) interval. Every subsequent response reset the interval, called the response–shock (R-S) interval, postponing the next shock delivery. By maintaining high rates of avoidance responding such that the R-S interval never elapsed, it was possible to study avoidance across extended periods in which no shock was delivered and in which no warning stimulus was presented. Sidman's seminal free-operant avoidance paradigm represented a challenge to two-factor theory, and it has been the subject of considerable investigation since that time (e.g., Herrnstein & Hineline, 1966; Hineline; Perone & Galizio, 1987).

Avoidance research with humans. Despite its obvious clinical implications and its central place in behavior-analytic accounts of behavior disorders (e.g., Eifert & Forsyth, 2007; Hayes, 2004; Hayes et al., 1996, 1999; Kanter et al., 2007), there has been surprisingly little operant research conducted on avoidance with humans. Some of the early studies with humans examined avoidance responding under conditions similar to those used in research with nonhumans (Ader & Tatum, 1961, 1963), and others sought to develop non-shock-based procedures in which avoidance responding prevented the withdrawal of a reinforcing event, such as children's cartoons or point delivery (Baer, 1961; Baron & Kaufman, 1966; Weiner, 1969).

Free-operant avoidance of carbon dioxide-enriched air (CO_2) was investigated by Lejuez, O'Donnell, Wirth, Zvolensky, and Eifert (1998). These authors sought to develop an alternative to shock as a translational research model of the escape and avoidance behavior involved in anxiety. Brief presentations of various concentrations and durations of CO_2 have been shown to induce many of the physiological (e.g., elevated heart rate) and self-reported (e.g., ratings of unpleasantness) symptoms of anxious episodes, yet it had not been demonstrated that CO_2 presentations functioned as aversive events in a free-operant avoidance procedure. Lejuez et al. arranged for CO_2 deliveries to occur every 3 s in the absence of responding. Each avoidance response (i.e., pulling a plunger) postponed CO_2 deliveries for 10 s. The authors observed stable rates of responding in a contingent condition compared with a noncontingent condition, demonstrating that avoidance responding was under discriminative control and that the CO_2 presentations indeed were functioning as aversive events (see also Fannes et al., 2008). A handful of other studies have examined human avoidance responding using shock (Augustson & Dougher, 1997) and aversive images and sounds selected according to the normative ratings provided by the popular International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005) and the International Affective Digitized Sounds (IADS; Bradley & Lang, 1999) databases as the putative aversive events (e.g., Dymond, Roche, Forsyth, Whelan, & Rhoden, 2007, 2008; Roche, Kanter, Brown, Dymond, & Fogarty, 2008).

In summary, despite the ongoing, seminal contributions of operant research on avoidance with nonhumans, research with humans has not progressed to the same extent. It is noteworthy that, following initial research interest in the topic during the 1960s (e.g., Ader & Tatum, 1961, 1963; Baer, 1961), the majority of the recent research on human avoidance has been conducted by researchers interested in derived relational responding and its relevance to understanding behavior disorders (e.g., Augustson & Dougher, 1997; Dymond et al., 2007, 2008; Roche et al., 2008). This recent trend in the human avoidance literature is unlikely to have occurred by accident because, for many authors, derived relational responding provides a unique contemporary functional analytic approach to understanding the complex novel behaviors often seen in clinical settings (e.g., Dymond & Rehfeldt, 2000; Hayes, Barnes-Holmes, & Roche, 2001). What, then, are the implications of research on derived relational responding for a contemporary understanding of behavior disorders such as anxiety and avoidance? In the next section, we address this question.

TOWARDS A CONTEMPORARY BEHAVIOR-ANALYTIC ACCOUNT OF AVOIDANCE

The foregoing models of fear conditioning and avoidance have not satisfied many behavior analysts in terms of their utility in explaining patterns of avoidance responses that cannot be easily traced to a specific history of reinforcement for escape (e.g., Rachman, 1977, 1991). More specifically, it has been noted that the inability of behavioral accounts to directly link anxiety conditions to past experiences has stimulated interest in cognitive accounts of anxiety (Marks, 1981). It does indeed appear that many cases of clinical anxiety and chronic avoidance patterns have emerged in the absence of a direct history of reinforcement for these behaviors. Such an observation clearly suggests to many that a mediating account in terms of cognitive processes is required. In the words of Rachman (1977),

> There are grounds for doubting whether the laboratory process of fear acquisition provides an adequate foundation for theorizing about fear acquisition in non-laboratory conditions, and in human subjects in or out of the laboratory. … Fears which emerge in the absence of any identifiable learning experience present notable difficulties for the theory. (p. 377)

A more sophisticated approach to the understanding of fear, anxiety, and avoidance is clearly required. As suggested earlier, inclusion of the phenomena known as derived relational responding and the transformation of functions might be crucial to developing a sophisticated analysis of anxiety. The analysis of derived relational processes has demonstrated the important fact that neutral stimuli can gain discriminative functions indirectly; that is, in the absence of the usual process for establishing discriminative control and in the absence of reinforcement (the transformation of discriminative functions is one example of many such functions; see Dymond & Rehfeldt, 2000). Thus, emotional responses can now be understood in terms of behavioral processes (i.e., derived relational responding) that were not previously available (see Dymond et al., 2003; Hayes, Barnes-Holmes, & Roche, 2001). Further, derived relational responding and the transformation of stimulus functions have opened up enormous research opportunities for behavior analysts interested in complex human behavior and emotion. To fully appreciate precisely how research into the development and treatment of avoidance and anxiety may benefit from recent research developments in derived relational responding, it is first necessary to briefly review this literature.

Derived Relational Responding

Since the early 1970s, a vast literature has shown that when verbally able humans are taught a series of interconnected conditional discriminations involving physically dissimilar (arbitrary) stimuli, the stimuli involved in those discriminations often become related to each other in ways that are not explicitly trained. To illustrate, if choosing Stimulus B in the presence of Stimulus A is taught (i.e., A-B), and choosing Stimulus C in the presence of Stimulus B (i.e., B-C) is also taught, it is highly likely that relations will emerge between B and A, C and B (called symmetry), A and C (called transitivity), and C and A (called combined symmetry and transitivity, or equivalence), in the absence of any further training. When these relations have been observed, a stimulus equivalence relation is said to have formed among the stimuli (Sidman, 1994).

These untrained, but nonetheless predictable, derived stimulus relations have been the focus of concerted research attention precisely because they are not readily explained by traditional behavioral principles of discrimination and stimulus generalization. Neither A nor C, for instance, have a history of differential reinforcement with regard to each other, so therefore neither should control selection of the other. Also, the findings cannot be accounted for on the basis of generalization because the stimuli are all physically dissimilar and cannot be explained via simpler conditioning processes (Hall, 1996).

Transformation of functions. Perhaps one of the most interesting aspects of research on derived relational responding is the transformation of functions. This involves training a particular behavioral function for one member of a derived relation and then observing that function emerge for one or more additional members of the derived relation without further training. This basic effect has been demonstrated in countless studies with functions such as Pavlovian eliciting, extinction and avoidance, self-discrimination, and self-reported mood functions, among others (for a review, see Dymond & Rehfeldt, 2000).

A clinically relevant example of the transformation of functions was provided by Dougher, Augustson, Markham, Greenway, and Wulfert (1994), who first trained and tested participants for the formation of two equivalence relations (A1-B1-C1-D1 and A2-B2-C2-D2). Next, a differential autonomic conditioning procedure was used in which one stimulus from one derived relation (i.e., B1) was established as a CS+ by brief pairings with an electric shock (US), and another stimulus (i.e., B2) was established as a CS− by pairings with the absence of shock. When a reliable conditioned response was established, as measured by skin conductance responses, Dougher et al. presented a series of test trials in which it was predicted that participants would also show a derived fear response to C1 and a derived relief response to C2, in the absence of the US. Results supported this prediction, with participants' skin conductance responses to the derived C1 and C2 stimuli (which were both presented in the absence of shock) being equivalent to those evoked during training of B1 and B2. It is important to note that no

US was presented during these test trials (i.e., extinction). Thus, the derived conditioned responding to both C1 and C2 must have emerged by virtue of the fact that they participated in derived equivalence relations with stimuli that had been directly conditioned. Dougher et al. also employed several control conditions to demonstrate that the derived transfer effect was not due to procedural artifacts or associative mechanisms.

This effect has also been shown in other research on derived relational responding with relations other than equivalence, such as sameness, opposition, difference, comparison (i.e., more than/less than), and before–after. These multiple stimulus relations mean that the changes that occur in stimulus functions when the stimuli participate in relations other than equivalence relations render terms such as *transfer of functions* too limited for generic use. As a result, *transformation of function* has been proposed, and adopted, as a generic alternative (Dymond & Rehfeldt, 2000). Imagine, for example, that Stimulus A is in an opposite relation with Stimulus B. We would not expect a strong reinforcing function for B to transfer to A. Rather, the function of B may be transformed, resulting in a diminished reinforcing or even punishing function for A. To state this example in a less abstract way, suppose you are told that the Welsh word *poeni* is the opposite of *pleasure*. Although pleasure may be highly valued, asking someone, "Do you want me to give you poeni?" will probably evoke avoidance, not approach. In fact, a number of studies have demonstrated this kind of derived relational responding (e.g., Dougher, Hamilton, Fink, & Harrington, 2007; Dymond & Barnes, 1995, 1996; Dymond et al., 2007, 2008; Roche & Barnes, 1997; Roche, Barnes-Holmes, Smeets, Barnes-Holmes, & McGeady, 2000; Whelan & Barnes-Holmes, 2004; Whelan, Barnes-Holmes, & Dymond, 2006).

Transformation of Functions Research on Clinically Relevant Fear and Avoidance

The transformation of functions and the impressive body of empirical evidence to support it may help to explain why people develop chronic avoidance patterns and anxiety conditions in the absence of a discrete history of fear and avoidance conditioning. Put simply, we now know that stimuli may acquire discriminative control over fear and avoidance responding by virtue of their participation in derived relations with perhaps only distantly related discriminative stimuli that have been established through direct experience. The most obvious process by which these derived relations might be established is through verbal processes. For example, when a snake-phobic client thinks about or hears the word *snake* and experiences an alarm response, not only is it likely that the word *snake* will function as a CS for fear (and as a discriminative stimulus for avoidance), but it is also likely that other stimuli that participate in equivalence relations with the word *snake* also will acquire similar functions (e.g., the word *reptile*, pictures of snakes, a real snake, and places where snakes might be found; see also Blackledge, 2003).

As well as the important demonstration of the transformation of eliciting and extinction functions through equivalence relations by Dougher et al. (1994; see also Roche & Barnes, 1997), there have been several recent studies on the transformation of clinically relevant fear and avoidance functions. For instance, Augustson and Dougher (1997) first used a differential conditioning procedure in which one stimulus was followed by shock (CS+) and another was not (CS−). Next, a signaled avoidance procedure was used in which the CS+ was presented and then followed by brief shock unless a fixed-ratio 20-response requirement was met. CS− presentations were never followed by shock. The high response rates showed that subjects avoided all but a maximum of two shocks during avoidance training, indicating that their responding was maintained by the postponement of future shock deliveries and that this responding was differentiated. This study was the first to show the emergence of avoidance responding to stimuli that had no direct relational history with aversive events. Thus, these findings help to explain how cases of clinical anxiety are sometimes observed in the apparent absence of a history of fear or avoidance conditioning for the relevant stimuli.

A recent series of studies by Dymond et al. (2007, 2008) further investigated the extent to which human avoidance functions can transform by employing multiple stimulus relations of same and opposite. To study multiple stimulus relations involves first training specific contextual cues using nonarbitrary stimuli related along formal dimensions, and then using these cues to establish arbitrarily applicable relations among stimuli that are not formally related. During the nonarbitrary training phase, Dymond et al. presented a contextual cue, a sample, and two or more comparison stimuli on each trial. The objective of this phase was to establish contextual functions for the two contextual cues. If the cue designated opposite was presented, choosing a comparison stimulus that is furthest removed from the sample along a specified physical dimension was reinforced. For example, given a large square as sample, choosing the smallest square among three or more squares of different sizes was reinforced. On other trials, the cue designated same was presented and choosing the comparison that is physically identical to the sample was reinforced. Participants were trained in this way across numerous exemplars of stimuli differing along various physical dimensions (e.g., big and small circles, thick and thin lines, few and many dots, etc.) until they responded accurately to novel samples and comparisons in the presence of the cues and in the absence of explicit differential reinforcement.

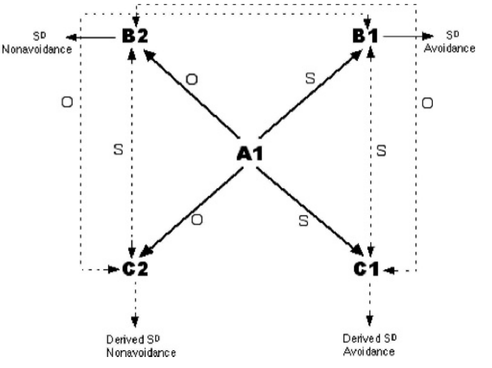

Figure 1. Relational network based on Dymond et al. (2007, 2008). Also shown are the directly trained and derived discriminative stimuli for avoidance (B1 and C1) and nonavoidance (B2 and C2). Solid lines indicate trained relations, and dashed lines indicate derived relations. S and O denote same and opposite relations, respectively.

Next, in the arbitrary training phase, the contextual cues were presented with samples and comparisons that were not related to each other along any consistent formal dimension, such as nonsense syllables or line drawings. In effect, contextual functions established during the nonarbitrary phase were arbitrarily applied, and participants came to relationally respond to arbitrary, physically dissimilar stimuli as if they were same and opposite to one another. The following stimulus relations were trained: same A1-B1, same A1-C1, opposite A1-B2, and opposite A1-C2. This led to the following derived relations: same B1-C1, same B2-C2, opposite B1-C2, and opposite B1-C1 (see Figure 1).

Dymond et al. (2007, 2008) then exposed participants to a signaled avoidance task, during which responding in the presence of B1 canceled a scheduled aversive image and sound (the images and sounds were selected from the IAPS and IADS, respectively). Another stimulus from the relational network, B2, was never followed by images or sounds. Once this avoidance response was acquired, participants were exposed to a probe phase in which C1 and C2 were presented in extinction. The majority of participants produced consistent avoidance responses in the presence of C1 but not C2 (i.e., C1 is the same as B1, whereas C2 is the opposite; see Figure 1), thus demonstrating the transformation of avoidance response functions in accordance with complex relational networks. The findings of Dymond et al. not only show that avoidance functions may transform in accordance with same and opposite relations—relations that characterize those seen in natural language (see Hayes, Barnes-Holmes, & Roche, 2001)—but also support the use of non-shock-based conditioning procedures.

Another recent study also demonstrated highly complex transformations of conditioned fear responses. Dougher et al. (2007) established relational contextual functions for three abstract visual stimuli. Specifically, in the presence of the sample stimuli, A, B, and C, participants were trained to select the smallest, medium, and largest member, respectively, of a series of three-comparison arrays. In the first experiment, the B (medium) stimulus was established as a discriminative stimulus for a steady rate of key pressing. The A and C stimuli were then presented to probe for a transformation of the steady response rate by these contextual cues. The authors observed that, compared to B, subjects pressed slower when presented with A and faster when presented with C, in the absence of further feedback. This finding confirmed the formation of a multiple stimulus relation of comparison across the three stimuli (i.e., A<B<C) and demonstrated the transformation of response rate functions in accordance with that relation. In the second experiment, Dougher et al. established the B stimulus as a CS+ using a differential fear-conditioning paradigm. Conditioned fear was quantified in terms of skin conductance responses. During the critical probe phase, participants were presented with A and C in the absence of the US. Compared to B, 6 of the 8 participants showed reduced skin conductance responses to A and increased changes in skin conductance responses to C. In this way, the functions of A and C were transformed by virtue of their derived comparative relation with the directly trained function attached to B.

In summary, the transformation of functions helps to explain complex instances of clinically relevant behavior, such as chronic avoidance patterns and anxiety conditions that develop in the absence of a direct learning history. The patterns of transformation that may arise outside the laboratory are of almost unimaginable complexity, yet the concept of the transformation of functions offers an empirical handle on this behavioral process. In so doing, it provides the behavioral researcher with a functional definition of verbal processes (Dymond et al., 2003) and an explanatory mechanism by which stimuli may acquire discriminative control by virtue of their participation in derived relations with distantly related discriminative stimuli that have been established through direct experience.

ILLUSTRATIVE EXAMPLES OF LABORATORY-BASED ANALOGUES OF TREATMENT PROCESSES

The foregoing findings serve to further support the idea that complex forms of derived fear and avoidance may occur in the world outside the laboratory (e.g., Hayes, 2004; Hayes et al., 1996, 1999) and may help us to address the criticism that learning theory cannot help to explain many complex cases of anxiety reported in the clinical setting. However, a complete model of avoidance must do more than simply provide a conceptually coherent account of the etiology of avoidance disorders. It should also allow development of analogue treatment processes based on that account (Roche et al., 2008). For instance, given the extent to which modern behavior therapy has explored the utility of traditional talk-therapy formats (e.g., Follette, Naugle, & Callaghan, 1996; Hayes et al., 1999; Kohlenberg & Tsai, 1991), it is surprising that no program of basic research has investigated the process of derived extinction to any great extent. This use of talk, rather than on direct contact with contingencies, might be conceptualized as involving derived relational processes, insofar as the response functions of statements from within the therapy setting must generalize to or transform the functions of stimuli and settings outside therapy. In modern behavior therapies, such as acceptance and commitment therapy (ACT; Hayes et al., 1999), there is a move towards a talk-therapy approach in which traditional techniques such as exposure and desensitization are being complemented and even replaced by modern techniques such as defusion. In what follows, we will outline three illustrative examples of research questions that arise when one considers developing laboratory-based analogues of key therapeutic processes. The first example concerns a comparison of direct and derived extinction of avoidance; the second example concerns the technique of defusion; and the final example addresses approach–avoidance conflict.

Direct Versus Derived Extinction of Avoidance

If we consider talk-based therapy from the perspective of derived relational responding as the transformation of extinction functions or contextual control over the transformation of functions, then the question immediately arises as to which intervention is more effective: traditional exposure-based extinction or derived extinction.

One recent study (Roche et al., 2008) has attempted to address this issue. In that study, 20 participants were first exposed to a relational training and testing sequence identical to that employed by Dymond et al. (2007), which resulted in the following derived same and opposite relations: same B1-C1, same B2-C2, opposite B1-C2, and opposite B1-C1. Next, participants were exposed to a signaled avoidance conditioning procedure in which B1 served as a discriminative stimulus for an avoidance response, and B2 served as a discriminative stimulus for nonavoidance. More specifically, pressing a computer keyboard space bar during the 3-s presentation of B1 prevented the presentation of an aversive IAPS image. All participants who showed stable avoidance responding to B1 also showed derived avoidance responses to C1 but not to C2, thus replicating the findings of Dymond et al. (2007, 2008).

In a subsequent phase, participants were exposed to either a traditional direct or a derived extinction procedure. In the direct extinction procedure, B1 and B2 were presented in extinction, whereas in the derived extinction procedure, C1 and C2 were presented in extinction. Both extinction procedures involved the presentation of discriminative stimuli for avoidance followed by aversive visual images. The operant response key for avoidance was disabled so that avoidance responses were no longer effective. The direct extinction procedure was designed to be an analogue of a traditional therapeutic exposure-based extinction technique. The derived extinction procedure was designed to be an analogue of the possible key process involved in talk therapies (i.e., transfer of extinction from words used in therapy to related stimuli).

Most participants in both conditions then demonstrated derived extinction of avoidance responding to the remaining stimulus relation members. More specifically, participants exposed to direct extinction (using B1 and B2) showed derived extinction of avoidance to C1, whereas subjects exposed to derived extinction (using C1 and C2) showed derived extinction of avoidance to B1. It is important to note that, following a predetermined number of extinction trials, extinction of the derived avoidance functions of C1 was more effective than extinction of the directly established avoidance functions of B1. This finding suggests that it is relatively easy to extinguish avoidance responses to stimuli that have acquired their functions through derived relational processes, whereas avoidance responses to directly aversive stimuli are more resistant to extinction. Moreover, and perhaps unexpectedly, the derived extinction procedure was more effective than the direct extinction procedure at extinguishing avoidance responses to all members of the stimulus relation taken together. More specifically, the extinction of avoidance to C1 transferred readily to B1 for most participants in the derived extinction condition, whereas avoidance of B1 in the direct extinction condition did not transfer to C1. In simple terms, the effect of the extinction procedure generalized across the derived relations more effectively when the derived, rather than the directly conditioned, aversive stimulus was targeted. Even more surprisingly, a greater extinction of avoidance was observed for B1 when C1 was targeted than was observed for B1 when B1 itself was targeted.

The findings of the Roche et al. (2008) study appear to show that derived extinction effects may be more powerful than direct extinction for both targeted and related stimuli. The authors suggested that a treatment implication of these findings is that avoidance might be most effectively treated by targeting the remote members of verbal relations (i.e., those containing the relevant aversive stimuli) rather than by direct exposure to the most likely original discriminative stimulus for avoidance. Put simply, it may be clinically more effective to target for extinction the individual's fear and avoidance of stimuli related to the aversive stimuli, rather that the feared object itself. This conclusion certainly supports the use of talk therapy techniques that appear to rely on derived extinction processes. Of course, it is a novel suggestion to target in therapy indirectly related stimuli rather than conditioned discriminative stimuli for avoidance, because exposure techniques leading directly to extinction are effective for many problems (Barlow, 2002). However, we maintain that this is precisely why empirical analyses of therapeutic processes are so urgently required, because such investigations often lead directly to solutions and provide pointers to possibly novel behavioral processes. For instance, directly targeting derived stimuli might lead to resurgence of the directly trained stimulus functions and necessitate additional direct extinction sessions. Procedures and findings from basic research may thus prove to be useful in understanding the treatment implications of therapy techniques that target derived extinction of avoidance functions (e.g., Lovibond, Davis, & O'Flaherty, 2000; Wilson & Hayes, 1996).

Defusion

Modern behavior therapies such as ACT (Hayes et al., 1999) rely theoretically on the fact that derived avoidance is a sufficiently frequent and powerful process outside the laboratory that it might underlie and even characterize many or most difficult cases of clinical anxiety (e.g., Eifert & Forsyth, 2007; Forsyth, Eifert, & Barrios, 2006; Hayes, 2004; Hayes et al., 1996). A widely used ACT technique known as defusion is conceptualized as altering the context for the derived transformation of avoidance functions in an attempt to undermine derived or directly acquired avoidance repertoires while the relevant verbal relations are left intact (see Blackledge, 2007). In simpler terms, defusion techniques are said to alter the undesirable functions of thoughts and other private events, rather than trying to alter their form, frequency, or situational sensitivity (Hayes & Wilson, 1994). Many such techniques have been developed to this end, but the most widely discussed form is what is known as the "milk, milk" or "deliteralization" exercise (see Masuda, Hayes, Sackett, & Twohig, 2004). This technique involves the repeated utterance of an aversive word or phrase by a client. The word might normally be discriminative for engaging in some avoidance or escape response, such as using distraction techniques or running away. However, after repeated utterances, the literal meaning of the word falls away (i.e., is extinguished) and only the formal features of the word (e.g., the aural functions) remain. In this way, the avoidance functions cease, at least temporarily, to dominate behavior.

How might derived relational responding and the transformation of functions account for the effects of defusion techniques? A working definition of the effects of defusion might appeal to the extension of contextual control over the transformation of functions such that words related to a feared event no longer evoke the avoidance response in a given context. According to relational frame theory (Hayes, Barnes-Holmes, & Roche, 2001), this is known as altering the contextual control that selects the particular response functions to be transformed in a given setting. In this case, the therapy setting, the presence of a therapist or subtle private events may initially serve to function as the contextual cue. However, with practice, the experience of confronting particular words or other relevant aversive stimuli may itself become the altered context for the transformation of avoidance functions, so that avoidance in the presence of the relevant stimuli becomes increasingly less likely over time.

To what extent, however, does the extinction of dominant discriminative functions in defusion occur by virtue of a change in the context for the transformation of functions as opposed to simple extinction or derived extinction (i.e., from the spoken word to other related stimuli; see Roche et al., 2008)? These two processes differ significantly, and the difference between them is easily ascertained with a simple experiment that has, to our knowledge, yet to be conducted. First, we need only repeat Augustson and Dougher's (1997) experiment to establish derived avoidance in accordance with a three-member equivalence relation. Next, we could conduct two analogue treatment conditions to ameliorate the laboratory-induced avoidance. In the first condition, we could use a technique similar to exposure to produce extinction of avoidance using the conditioned discriminative stimulus for avoidance. Across a controlled number of trials, we should observe decreases in frequency and probability of avoidance responding to the target stimulus (i.e., extinction) and equivalently related stimuli (i.e., derived extinction; see Roche et al., 2008, for empirical evidence).

In the second condition, however, we could use a defusion technique to reduce avoidance of the laboratory conditioned discriminative stimulus. If defusion leads to an alteration in the context for the transformation of functions, rather than mere extinction and derived extinction via exposure, a number of specific differences between the two condition outcomes should be observed. First, the derived relations should be easier to parse into further derived relations following the defusion intervention due to the fact that, in at least one context (i.e., the context of the defusion exercise), they no longer share a salient emotional function (see Roche, Barnes, & Smeets, 1997, and Tyndall, Roche, & James, 2004, for supporting empirical evidence). In other words, the derived relations in the second condition should have measurably increased in contextual flexibility compared to the derived relations in the first condition. Second, we might expect to see a difference in the effectiveness of the two techniques in reducing derived avoidance, because if they involve different fundamental processes this may well lead to nonidentical outcomes. Third, following the defusion condition we should observe near-pretreatment avoidance levels (while accounting for the effects of habituation) in at least some contexts other than those presented during the defusion treatment. This should not be as apparent in the direct avoidance condition, which is conceptualized traditionally as extinguishing the avoidance response itself in a way that should span many or all contexts, through direct contact with the nonaversive consequences of failing to avoid. If we do not see some avoidance responding in novel contexts following the defusion condition, it would suggest that contextual control over extinction of avoidance has spontaneously expanded to infinity, making it indistinguishable from traditional extinction as employed in the first condition. If this were to occur, further important empirical questions would arise. Indeed, if such research fails to distinguish between defusion and derived extinction processes altogether, this would pose important questions about the need for separate terminologies to describe each.

Approach–Avoidance Conflict

A challenge for modern behavioral accounts of avoidance and anxiety is to capture the multitude of stimulus functions present in real-world anxiety-provoking stimuli. Early behavior therapy research characterized anxiety simply in terms of avoidance, but this idea was eventually challenged (e.g., Costello, 1970, 1971; Powell & Lumia, 1971; Wolpe, 1971). More recently, researchers have made the case that in real-world anxiety, approach and avoidance contingencies may work together to produce the distress associated with the anxiety often reported in therapy (Forsyth et al., 2006; Hayes, 1976). In other words, many people seeking therapy for acute or chronic anxiety experience regular approach–avoid conflicts in addition to displaying well-established avoidance repertoires (e.g., "I want to drive to work but I can't because I might panic").

A limited amount of research has focused on approach–avoidance conflicts in humans, but none have originated from within behavior analysis (Epstein & Fenz, 1962; Fenz & Epstein, 1967). However, research conducted in the context of a derived transformation of approach–avoidance conflicts would lend itself readily to an experimental analysis. Imagine, for example, that a derived relation is established in which each of two stimuli have laboratory-induced discriminative functions for approach and avoidance, respectively. If the approach and avoidance responses were equally reinforced, what would happen when remaining relation members were presented? Would a participant show significant behavioral disruption, such as long response delays or failure to respond at all? If so, approach–avoidance conflicts might serve as an appropriate analogue for panic. More interestingly, would the anxiety created by the approach–avoidance conflict equal or even surpass the anxiety generated by the presentation of a discriminative stimulus for avoidance alone? These and related empirical questions can be readily addressed. The findings of such research would have immediate significance for our understanding of the anxiety condition in terms of known behavioral processes.

These illustrative examples are just a sample of the testable questions that arise regarding therapeutic processes when one applies the derived relations paradigm. Many more questions can be easily generated to test the role of derived relational processes in various treatment methods and to examine their utility as a paradigm for a contemporary behavioral analysis of the etiology and treatment of fear, anxiety, and avoidance.

CHALLENGES AND OPPORTUNITIES FOR BEHAVIOR ANALYSIS

As we suggested earlier, some of the associative learning theorists who conduct research on avoidance have become increasingly interested in the relation between conditioning outcomes and verbal processes (e.g., De Houwer, 2009; De Houwer, Vandorpe, & Beckers, 2005; Lovibond & Shanks, 2002). According to Lovibond, for instance, verbal processes mediate conditioning with humans to the extent that verbal, relational abilities may in fact be necessary for conditioning to occur:

> This research suggests that (a) knowledge derived from conditioning experiences is encoded in propositional form, such that it can be integrated with knowledge acquired symbolically, and (b) elicitation of behavior is tied to the outcome of propositional analysis rather than to earlier or lower level cognitive processes. (Lovibond, 2006, p. 124).

From a behavior-analytic perspective, derived relational responding generally, and the transformation of functions specifically, provide the processes by which "knowledge" is "acquired symbolically" and may come to subsequently control conditioned responding.

In terms of anxiety and avoidance, Lovibond (2006) also was clear that "an important task for future clinical research is to determine the optimal combination of language and experience for various anxiety disorders" (pp. 129–130). Thus, some conditioning models seem to be moving from direct-contingency-based explanations to an acceptance of the role of derived, verbal processes in explaining the etiology and maintenance of anxiety. A closer synthesis of procedures from associative learning research with those from derived relational responding appears to be a potentially fruitful line of inquiry for future research (for a recent example, see Smyth, Barnes-Holmes, & Barnes-Holmes, 2008).

Moving from Demonstration to Translational Research

Many of the studies on transformation of clinically relevant behavior conducted to date may be considered examples of demonstration research. That is, they establish "proof of principle" by showing, for instance, that avoidance response functions may transform in accordance with contextually controlled relations of same and opposite (Dymond et al., 2007). Such findings, however, do not justify the conclusion that clinical anxiety routinely or ever arises in the same way. This is the case even when the treatment protocol employed is based on a derived relations approach (e.g., a defusion technique) and is shown to be effective. It is important to understand, therefore, the distinction between a theoretical explanation of psychopathology based on proof-of-principle demonstrations and one in which a given process is shown to occur in the real world for real clients (e.g., changes in the contextual control over the transformation of function; see Blackledge, 2007). Behavior analysis has produced a modest proof-of-principle literature to help to explain real-world anxiety and avoidance, but not a single published empirical study to date has shown that derived relational processes occur during anxious episodes, during the development of anxiety or related conditions, or during the application of therapeutic techniques (but see Roche et al., 2008).

The further development of contemporary behavioral models of anxiety and avoidance requires translational research in which "findings from the laboratory are replicated with and extended to clinical populations and problems" (Lerman, 2003, p. 415). An obvious next step, therefore, is to undertake extensions of laboratory findings on avoidance with clients diagnosed with anxiety disorders and with subclinical groups categorized as high or low in anxiety according to validated psychometric measures. Translational research of this kind is commonplace in experimental psychopathology, but behavior analysis has yet to make similar inroads with high-incidence behavior disorders. Embarking on this endeavor is especially urgent due to the rapid emergence of several new treatment techniques within modern behavior therapy that are based on the concept of derived relational responding (e.g., Forsyth & Eifert, 2008; Hayes et al., 1999).

CONCLUSION

The behavior analysis of anxiety is a field rich in powerful methodologies and coherent theoretical frameworks, and is now complemented by a newly emerging derived relations paradigm. Nevertheless, we are a field that is becoming increasingly top-heavy with theory and bottom-light with data. Only a handful of laboratories worldwide are currently pursuing the experimental analysis of anxiety from a behavior-analytic perspective. The current paper has, however, provided the reader with an outline of some new and exciting methodologies that can be employed to extend these various research programs. We also provided examples of the types of empirical questions that require our attention at this time. We contend that, given recent conceptual developments in the analysis of anxiety and avoidance, behavior analysis now has the opportunity to participate fully in the analysis of anxiety alongside our contemporaries in mainstream clinical and experimental psychology. At the same time, however, if we fail to grasp this opportunity, the analysis of clinical anxiety will continue without us.

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