The Interfering Effect of Emotional Stimulus Functions on Stimulus Equivalence Class Formation: Implications for the Understanding and Treatment of Anxiety

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The present experiment examined the effects of respondently conditioned emotional functions on the formation of stimulus equivalence relations. Fifty-seven participants were exposed to a stimulus-pairing procedure that paired six nonsense syllables with aversive images, and a further six stimuli with neutral images. A second phase established different operant response functions for one aversive CS and one neutral CS. In Phase 3, 45 of the 57 participants demonstrated a transfer of the established operant response to stimuli sharing respondent functions, thereby demonstrating the formation of two functional classes. Using a between-subjects design, participants were then exposed to a conditional discrimination training and testing protocol designed to establish two three-member stimulus equivalence relations using either six aversive or six emotionally neutral CSs as stimuli. Participants required significantly more testing trials to form stimulus equivalence relations when all stimuli had emotionally aversive functions compared to neutral functions. Implications of this study for the treatment of clinical anxiety are considered.

Keywords: Functional Stimulus Classes, Anxiety, Stimulus Equivalence, Functional Equivalence, Humans.

A recent special issue of *The Behavior Analyst* (Vol. 32, 2009) was devoted to outlining the latest advances and current developments in the field that has been termed *clinical behavior analysis* (CBA; Dougher, 1993). Several researchers described how behavior analytic principles can be applied to the understanding of the development, maintenance, and treatment of problem behaviors such as anxiety, avoidance, depression, and chronic substance abuse (e.g., Christopher & Dougher, 2009; Dymond & Roche, 2009; Follette & Bonow, 2009; Vilardaga, Hayes, Levin, & Muto, 2009; Waltz & Follette, 2009; Wray, Freund, & Dougher, 2009). These papers are timely and to be wel-

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comed, particularly when viewed in the light of a number of review articles that appeared just over a decade earlier, which highlighted the lack of basic behavior-analytic research on such prevalent problem behaviours as anxiety and avoidance (e.g., Forsyth & Eifert, 1996; Friman, Hayes, & Wilson, 1998).

One criticism that remains of research in this particular area is that much of the analysis of the aetiology and maintenance of such problem behaviors and clinical disorders (e.g., social phobia) is still heavily theoretical and inferential, rather than having a solid grounding in a literature comprising a large body of empirical studies on the behavioral processes involved. Similarly, with regard to therapeutic strategies employed to target problem behaviors, Follette and Bonow (2009) acknowledged that "In spite of the success derived from applying behavior analysis to adult outpatient problems whenever it has been attempted, clinical behavior analysts have been relatively slow to examine the processes of change that occur during the psychotherapy itself and the mechanisms by which changes are produced" (p. 136). However, a few modern behavior therapies have recently emerged, including Acceptance and Commitment Therapy (ACT; Hayes, Strosahl, & Wilson, 1999), and Functional Analytical Psychotherapy (FAP; Kohlenberg & Tsai, 1991), that endeavour to examine some of the processes involved in producing lasting behavior change in psychotherapy settings.

Adult outpatient psychotherapy sessions are heavily reliant on the vocal verbal behavior of both the client and therapist (Hayes, et al., 1999; Wilson & Hayes, 2000). Moreover, many behavior analysts now agree that verbal processes are likely involved in the acquisition of complex forms of anxiety (e.g., Augustson & Dougher, 1997; Dougher, 1998; Dymond & Rehfeldt, 2000; Dymond & Roche, 2009; Forsyth, 2000; Forsyth & Eifert, 1996; Friman, et al., 1998; Hayes, Strosahl, & Wilson, 1999; Hayes & Wilson, 1993, 1994; Tierney & Bracken, 1998). The role of verbal behavior in behavior-analytic accounts of anxiety has been revisited with a view to addressing gaps in our understanding of the processes involved in the development, maintenance, and treatment of clinical anxiety (e.g., Dougher, Hamilton, Fink, & Harrington, 2007; Dymond, Roche, Forsyth, Whelan, & Rhoden, 2007; Wray, et al., 2009).

In an attempt to understand verbal processes, behavior analysts have turned to a phenomenon known as derived relational responding, and in particular an effect known as stimulus equivalence. The phenomenon of stimulus equivalence, first outlined by Sidman (Sidman, 1971, 1990, 1994, 2000; Sidman & Tailby, 1982), has been put forward as a behavioural process that may help to shed some light on situations where the behaviors are apparently 'emergent' (i.e., cannot be traced to direct contingencies: e.g., Follette, 1998; Pilgrim & Galizio, 2000; Roche & Barnes, 1997; Saunders & Green, 1999). The stimulus equivalence paradigm has been employed to demonstrate how relations can emerge between stimuli that were not directly trained or paired together and also to suggest that the phenomenon of stimulus equivalence appears to be closely related to language or verbal processes (e.g., Barnes, 1994; Barnes-Holmes, Barnes-Holmes, Smeets, Cullinan & Leader, 2004; Sidman, 1994). This has potential for addressing some of the criticisms of behavioral accounts of clinical anxiety in the absence of conditioning histories for many clients suffering from anxiety disorders (e.g., Augustson & Dougher, 1997; Field, 2006; Lazarus, 1984; Poulton & Menzies, 2002; Rachman, 1977; Rodriguez, Luciano, Guitierrez, & Hernandez, 2004).

Stimulus equivalence research typically involves teaching participants to match comparison stimuli to sample stimuli in conditional discrimination training using a matching-to-sample procedure. For example, in the presence of an arbitrary stimulus A1 (sample), choosing another stimulus B1 (comparison) is reinforced. Then, choosing C1 (comparison) in the presence of B1 (sample) is reinforced. Stimulus equivalence requires that participants then choose C1 in the presence of A1 (transitivity) and can reverse both the trained relations (choose A1 in the presence of B1 and C1 in the presence of B1; symmetry). Choosing A1 as a comparison when C1 is a sample (combined symmetry and transitivity) is often employed as the test of the emergence of the equivalence relation (e.g., Sidman & Tailby, 1982).

Of partiular relevance to the issue of anxiety is the derived transfer-of-function effect. This transfer-of-function effect is the phenomenon observed when the behavioral functions of stimuli transfer via equivalence classes to other stimuli which previously did not elicit or control that behavior (e.g., Dougher, Augustson, Markham, Greenway, & Wulfert, 1994). In general, if one of the stimuli in an equivalence class is established as a discriminative stimulus for a simple response then other class members will spontaneously acquire discriminative properties without further training (Dymond & Rehfeldt, 2000).

The transfer-of-functions effect is a powerful method of extending a person's behavioral repertoire and can help account for much adaptive behaviour in the absence of direct training or reinforcement. However, as noted by Leslie and O'Reilly (1999), it "may also contribute to less desirable outcomes by providing a rapid method of attaching fear and anxious behaviour to specific situations that were not previously feared" (p. 97). To test this idea, Augustson and Dougher (1997) trained eight participants in the formation of two four-member equivalence classes. They subsequently established an avoidance response (CS+) – pressing the spacebar on a computer keyboard 20 times prior to the potential administration of a mild electric shock – for a discriminative stimulus (B1) that was also a member of one of the equivalence classes (A1-B1-C1-D1). The avoidance response was shown to transfer to the other members of the particular equivalence class and not to members of the other equivalence class (A2-B2-C2-D2). The authors used the observed transfer of function across stimulus equivalence classes to help explain, at least in part, the aetiologies of avoidance responses that appear to have emerged in the absence of any explicit history of reinforcement for avoidance in the natural environment, while acknowledging that as a mere experimental analogue the levels of conditioned responding observed were not clinically significant (see also Dougher, et al., 1994; Dougher, et al., 2007; Dymond, et al., 2007; Friman, et al., 1998; Roche, Barnes-Holmes, Smeets, Barnes-Holmes, & McGready, 2000).

Some authors have suggested (e.g., Hayes, et al., 1999; Hayes & Wilson, 1994) that malformed or problematic equivalence relations may characterise many clients with anxiety disorders presenting for therapy. For example, imagine a client who thinks to themselves 'If I see a spider I will die'. The individual is demonstrating a stimulus relation or class between the terms die and spider. Many therapists would consider such a relation to be maladaptive or malformed. Thus, it may be important to understand how to target or 'break-up' these maladaptive classes. Indeed, a number of researchers have examined whether or not established functional or stimulus equivalence classes can easily be reorganised (e.g., Dixon, Rehfeldt, Zlomke, & Robinson, 2006; Pilgrim, Chambers, & Galizio, 1995; Pilgrim & Galizio, 1990, 1995; Roche, Barnes, & Smeets, 1997; Smeets, Barnes-Holmes, Akpinar, & Barnes-Holmes, 2003; Smeets, Barnes-Holmes, & Striefel, 2006; Wirth & Chase, 2002). Wilson and Hayes (1996) noted that two types of reversal training procedures have generally been employed in the empirical literature, complete reversal and partial reversal. Complete reversal involves reversing all initially trained relations and often produces equivalence reversal. Partial reversal is more commonly used which involves reversing only some of the trained relations and is usually less successful in reversing the established equivalence relations. While some suggestions have been made (e.g., Roche, et al., 1997) as to the conditions under which established equivalence relations can be reorganised the general finding is that equivalence relations, once formed are difficult to change (e.g., Follette, 1998; Rehfeldt & Hayes, 2000; Wirth & Chase, 2002), with symmetry relations generally more sensitive to contingency reversals than symmetric transitivity (equivalence) relations (Smeets, et al, 2003).

Researchers have also examined the effect of pre-experimental history on the formation of stimulus equivalence classes. For instance, in one study, Leslie, Tierney, Robinson, Keenan, Watt, and Barnes (1993) examined the possibility that pre-experimentally established fear of specific stimuli might interfere with the formation of stimulus equivalence classes. Seven of eight patients diagnosed with generalised anxiety failed to show evidence of equivalence class formation containing aversive stimuli as A-elements (e.g., public speaking, job interview) and pleasant adjectives as C-elements (e.g., relaxed, content), in a linear training protocol. In contrast, six of the eight control participants formed the expected equivalence classes using the same stimuli (see also Moxon, Keenan, & Hines, 1993; Watt, Keenan, Barnes, & Cairnes, 1991)

In another study, Plaud (1995) exposed fifty-one female participants to matching-to-sample training designed to form two three-member stimulus equivalence classes from a set of six snake-related words (aversive stimuli) and two three-member equivalence classes from a set of six flower-related words (neutral stimuli). The data indicated that 29 of the 51 participants required significantly more training and testing blocks to form equivalence classes in the snake-related than the flower-related condition. Interference in forming equivalence classes with snake-related stimuli also correlated with self-reported fear of snakes. Plaud (1995) suggested that interference with the formation of stimulus equivalence classes was due to the emotionality, in other words aversive nature, of the stimuli. However, in a subsequent study employing male and female participants, Plaud (1997) failed to observe a relation between the "interference effect" and a fear of snakes.

More recently, Tyndall, Roche, and James (2004) examined the basic process that may have been at work in the Plaud (1995) study. Specifically, Tyndall et al. established two sets of stimuli; six S+ stimuli (i.e., produce a simple operant response to the stimulus) and six S- stimuli (i.e., respond away). The stimuli and simple operant responses were emotionally innocuous in all cases. In general, participants required more testing blocks form two three-member stimulus equivalence classes from among the six S+ stimuli than the six S- stimuli. This finding suggested that stimuli with shared functions (i.e., functional classes) are more difficult to organise into incongruous stimulus equivalence classes than stimuli with less salient or weak shared functions. However, in that study Tyndall et al. failed to undertake any definitive test for the formation of two functional classes prior to stimulus equivalence training and testing. It may well have been that only one functional class was formed in the first instance (i.e., the S+ class). Moreover, it may be that "interference effects" are considerably more marked when stimuli are high in emotional valence in addition to forming a functional class. The current study was designed to address these two issues in the context of a laboratory study in which full experimental control was obtained over all emotional functions.

The present study was designed to improve and extend upon the Tyndall et al. (2004) study and to help elucidate the complex relationship between functional equivalence and stimulus equivalence (see Dougher & Markham, 1994, 1996; Dymond & Rehfeldt, 2000; Fields, 2001; Hall, 2001; Markham & Markham, 2002; Minster, Jones, Eliffe, & Muthukamarasawmy, 2006; Smeets, Barnes, & Roche, 1997; Tonneau, 2001; Tonneau & Gonzalez, 2004, Wirth & Chase, 2002). In this study, six nonsense syllables were directly paired with six aversive images and a further six nonsense syllables were paired directly with six neutral images to establish two respondent function stimulus classes, an Aversive Stimulus class and a Neutral Stimulus class. One CS from the aversive class was then employed as a discriminative stimulus in a simple operant training paradigm. A second stimulus from the neutral set was also established as a discriminative stimulus for a distinct simple operant response. A stringent test for functional class formation was then employed. That is, a functional class was said to have been established only among those stimuli which shared an untrained discriminative response function with an original trained discriminative stimulus. Subsequent stimulus equivalence training and testing phases examined whether there were differences in rates of equivalence class formation in the aversive and neutral stimulus conditions. Previous research (e.g., Plaud, 1995, 1997; Tyndall, et al., 2004) suggests that the Aversive Stimuli would hinder the formation of stimulus equivalence relations in comparison to the Neutral Stimuli.

Method

Participants

Fifty-seven volunteers participated in the present experiment. There were 25 males and 32 females aged between 20 and 49 with a mean age of 26.77 years (SD = 7.26 yrs). All participants were recruited as volunteers through notice board advertisements and through personal contacts. Thirty-eight of the participants were undergraduate psychology students. The remaining 19 were employed in a variety of occupations but had all received third level education. No participant had studied stimulus equivalence as a part of their undergraduate training and all participated without remuneration. Forty-three participants were Irish, while the remaining 14 participants included persons from the United States of America, Germany, England, Scotland, United Arab Emirates, Poland, Guatemala, Kenya, the Maldives, and St. Kitts & Nevis. All were fully fluent in the English language. Twelve of the 57 participants failed to demonstrate the required derived transfer of stimulus functions in Phase 3 of the experiment (see Procedure section below), and thus only the remaining 45 participants proceeded to the equivalence training phase (Phase 4). In order to determine assignment to condition the remaining participants were asked to place their hand inside a small box with their eyes closed and 'blindly' pick a card. There were two cards inside, 3 cm x 5 cm, with 'ASC' printed on one and 'NSC' printed on the other. The participants who picked out the 'ASC' card were exposed to equivalence training in the Aversive Stimulus Condition, while those who picked out the 'NSC' card were exposed to equivalence training in the Neutral Stimulus Condition. It should be noted that with this method, 23 of the first 42 cards drawn out was the 'ASC' card. Thus, the last three participants in succession were all automatically assigned to the Neutral Stimulus Condition without picking out a card. Three participants did not meet the pre-determined criterion in the equivalence training phase. Thus, a total of 42 of the original sample of 57 participants proceeded to the final critical phase of the experiment (Phase 5; stimulus equivalence test). There were 21 participants in each of the two conditions (i.e., Aversive Stimulus and Neutral Stimulus conditions). In the Aversive Stimulus condition there were eight males and 13 females (M = 26.45 yrs; SD = 7.21 yrs). In the Neutral Stimulus condition there were 10 males and 11 females (M = 27.21 yrs; SD = 7.12 yrs).

Materials and Apparatus

The experiment was conducted in the psychology laboratory room at American College Dublin (ACD). Each of the 57 participants was tested in an individual session. All participants sat at a desk facing an Apple Macintosh iBook ® laptop with a 13 in. screen. The experimental software, written using *PsyScope* 1.2.4 PPC (see Cohen, MacWhinney, Flatt, & Provost, 1993; Roche, Stewart, & Barnes-Holmes, 1999), controlled all stimulus presentations and the recording of responses. The pictures employed as unconditioned stimuli (US) in this particular study were selected from the most recent edition of the *International Affective Picture System* (IAPS) catalogue (Lang, Bradley, & Cuthbert, 2005), which is a large set of standardised, emotionally-evocative, internationally accessible, colour photographs commonly used in research on emotion (e.g., Dymond, et al., 2007; Smith, Lang, & Bradley, 2005).

Stimuli

The unconditioned stimuli (US) employed in the present experiment were 12 colour photographs selected from the IAPS catalogue. Six of the pictures were aversive photographs depicting badly mutilated human faces. The pictures were numbered in the IAPS as; 3000, 3010, 3060, 3069, 3080, and 3170, respectively, and had a standardised valence range of 1.46 to 1.79 (highly unpleasant) with a standardised arousal range of 7.01 to 7.26 (highly arousing). These images selected were approved for use in the current research by the ACD Research Ethics

Committee. The remaining six photographs were chosen to represent a set of stimuli that were emotionally neutral in relation to the levels of arousal and valence they typically elicit according to the normative sample data provided by the IAPS. The six photographs all depicted varieties of mushrooms and were numbered 5500, 5510, 5520, 5530, 5533, and 5534 in the IAPS catalogue. The mushroom pictures had a standardised valence range of 4.84 to 5.42 (neither pleasant nor unpleasant) and a standardised arousal range of 2.82 to 3.14 (low arousal properties) (see Table 1).

Twelve nonsense syllables served as the Conditioned Stimuli (CS) in the stimulus-pairing (i.e., associative-conditioning) phase of the experiment (i.e., JOP, ZID, CUG, REB, KAR, VIM, LEK, PAF, RIT, JOM, LUB, and CAZ). Each stimulus appeared on the computer screen in white *Times* 32-point on a black background. In the MTS training and equivalence-testing phases of the experiment they were arbitrarily assigned as samples and comparisons. For convenience, the stimuli were designated alphanumeric labels (A1, B1, C1, A2, B2, C2, A3, B3, C3, A4, B4, and C4) although the participants did not see these designations.

Procedure

Overview: Phase 1 was designed to establish two respondent-based functional stimulus classes, an Aversive Stimulus class (A1-B1-C1-A2-B2-C2) and Neutral Stimulus class (A3-B3-C3-A4-B4-C4), for all participants. The aim of Phase 2 was to establish separate basic operant functions for two of the conditioned stimuli employed in Phase 1 (i.e., one from each functional class). Phase 3 was comprised of a test for the operant functions for other members of the functional classes. This was intended to confirm that the two sets created did in fact constitute functional classes as defined by Dougher and Markham (1994, 1996). Phases 4 and 5 consisted of stimulus equivalence training and testing, respectively, and employed a matching-to-sample (MTS) procedure to establish two three-member stimulus equivalence classes from among the six stimuli in each of the two functional stimulus classes.

Phase 1: Stimulus-Pairing phase. At least 24 hours prior to being exposed to the stimulus-pairing procedure, participants were required to read and sign an Informed Consent form acknowledging their awareness of the aversive nature of some of the images that they were about to see. They were also informed that they were free to change their minds regarding participation prior to the study and that they could terminate their participation at any time. Each participant was seated at a desk in front

Table 1. Mean valence and arousal ratings for each of the six picture stimuli in both the Aversive Stimulus and Neutral Stimulus conditions established in Phase 1 Stimulus-Pairing (i.e., Associative Conditioning; 12 pictures in total). Standard deviation scores are presented in parentheses.

Condition	Picture Label	Picture Identification Number	Picture Valence Ratings	Picture Arousal Ratings
Six Aversive Stimulus Pictures	Mutilation	3000	1.59 (1.35)	7.34 (2.27)
	Mutilation	3010	1.79 (1.56)	7.26 (1.86)
	Mutilation	3060	1.70 (1.41)	7.12 (2.09)
	Mutilation	3069	1.70 (1.41)	7.03 (2.41)
	Mutilation	3080	1.48 (0.95)	7.22 (1.97)
	Tumour	3170	1.46 (1.01)	7.21 (1.99)
Six Neutral Stimulus Pictures	Mushroom	5500	5.42 (1.58)	3.00 (2.42)
	Mushroom	5510	5.15 (1.43)	2.82 (2.18)
	Mushroom	5520	5.33 (1.49)	2.95 (2.42)
	Mushroom	5530	5.38 (1.60)	2.87 (2.29)
	Mushrooms	5533	5.31 (1.17)	3.12 (1.92)
	Mushrooms	5534	4.84 (1.44)	*3.14 (2.03)*

of the iBook ® laptop computer. Twelve nonsense syllables were individually paired with 12 photographic images, six aversive photographs depicting mutilated faces and six neutral photographs depicting mushrooms. Thus, the procedure was designed to establish two functional stimulus classes, the first comprising six similar aversive stimuli and the second consisting of six similar neutral stimuli. The instructions for Phase 1 appeared on screen as follows:

"In a moment some words and images will appear on this screen. Your task is to look at these items carefully and to remember what you see. IT IS VERY IMPORTANT THAT YOU CONTINUE TO WATCH THE SCREEN AT ALL TIMES. After each picture has been presented you will be required to press the space bar on the computer keyboard to continue. Please make sure you know where the spacebar is before you begin. REMEMBER – IT IS VERY IMPORTANT THAT YOU PAY CLOSE ATTENTION TO WHAT IS HAPPENING ON THE COMPUTER SCREEN. If you have any questions please ask them now. When you are ready to begin please click the mouse button."

Each nonsense syllable appeared on screen for two seconds followed 0.5 s later by an aversive or emotionally neutral picture that remained on screen for 3 s. The participant pressed the spacebar after each trial pairing and there was a random inter-trial interval of between 8 and 12 s between successive trials. There were 108 trials in Phase 1 stimulus-pairing which comprised of three blocks of 36 trials. Within each block of 36 trials there were three exposures to each of the 12 conditioned stimuli. Previous research in our laboratory suggested that this was an efficient number of trials to produce effective conditioning in stimulus pairing procedures. After each block of 36 trials the following message appeared on the screen:

"Have you been paying careful attention to the Words and Pictures that are appearing on-screen? It is important for later stages of this study that you pay close attention to these words and pictures now. Press the space bar now."

This message was presented in red *Times* 28-point font and remained on screen for 5 s followed by the random inter-trial interval of between 8 and 12 s.

During the stimulus-pairing procedure A1, B1, C1, A2, B2, C2 (i.e., A1 through C2) were always paired with an aversive image, while A3, B3, C3, A4, B4, C4 (i.e., A3 through C4) were always paired with a neutral image. However, particular aversive or neutral images associated with each of A1 through C2 and A3 through C4 were chosen randomly by the computer software on each trial. At the end of Phase 1 the following message appeared on screen: "You have finished this stage of the experiment. PLEASE CONTACT THE EXPERIMENTER NOW".

Phase 2: Operant Stimulus Function training. Phase 2 was designed to establish an operant response function for two nonsense syllables, one from each functional class, in a forced choice procedure. The two stimuli selected were A1 (JOP) from the Aversive Stimulus class and A3 (LEK) from the Neutral Stimulus class. Participants were exposed only to the actual nonsense syllables, not their alphanumeric designations. The operant function training phase consisted of two sections: (a) Function Training, and (b) Function Testing. The instructions for Phase 2 Function Training were as follows:

"Your task is to do the right thing in response to each of the items that appears on the screen. You can press the 'X' key on the keyboard or the 'space bar'. Each time you will be provided with feedback on your choice. Make sure you know where the space bar and the 'X' key are located. It is important that you pay close attention as you will later be tested on what you have learned. Press any key to begin."

Thus, when stimulus A1 was presented on screen pressing the 'X' key on the keyboard was reinforced. All other key presses were not consequated in any way. The word 'correct' appeared in red Times 32-point in the centre of the screen for 2 s along with a brief high pitch tone (i.e., a beep) following the appropriate response. When A3 was presented pressing the spacebar on the computer keyboard was reinforced. Again, no other response was reinforced or punished. The word 'correct' and the high pitch tone were only presented following a spacebar press response.

A1 remained on screen until the participant pressed the 'X' key and A3 remained on screen until the spacebar was pressed. The two stimuli were presented in a quasi-random order with no more than two successive presentations of either stimulus. Operant function training continued until participants made 10 successively correct responses to each of the two stimuli (i.e., 20 correct responses). The participants then moved on to the Function Testing procedure that presented 20 trials employing the same two stimuli (A1 and A3) in a quasi-random order (i.e., 10 trials with each stimulus). The instructions for Phase 2 Function Testing appeared on screen as follows:

> "Your task is to do the right thing in response to each of the items that appears on the screen. You can press the 'X' key on the keyboard or the 'space bar'. This time YOU WILL NOT be provided with feedback on your choice. Make sure you know where the spacebar and 'X' key are located. It is important that you make as many correct responses as possible. Press any key to begin."

No feedback was provided in the Function Testing phase. The stimulus was removed from the computer screen immediately on the production of a response. The criterion for passing this test phase was responding correctly on nine out of 10 trials for each stimulus; a minimum of 18 correct responses out of 20 test trials. If a participant failed to meet this criterion on their first run they were administered the Function Test a second time. Any participant who failed to meet the criterion on the second running of the Function Test was dropped from further participation in the study.

Phase 3: Transfer-of-Function Test. The transfer-of-function test was designed to examine if the operant response function trained for one member of each stimulus class established in the stimulus pairing (associative conditioning) phase transferred to the other five members of each stimulus class, either Aversive Stimulus class or Neutral Stimulus class, and not to members of the other class. The instructions for Phase 3 Transfer-of-function test appeared on screen and were identical to the instructions given for Phase 2 Function Testing above. Thus, participants were told that they would not be provided with feedback on their response selections.

All 12 stimuli, six from each stimulus class including A1 and A3 which had been employed in Phase 2 Operant Function Training, were presented three times each in a quasi-random order. Thus, there were 36 trials in total. The procedure was the same as in Phase 2 Function Test in that the stimulus was presented in the centre of the screen in white Times 32-point on a black background and disappeared when a response was made. For stimuli A1, B1, C1, A2, B2, and C2 the correct response was to press the 'X' key and for stimuli A3, B3, C3, A4, B4, and C4 the correct response was to press the space bar. The criterion for passing the transfer-of-function test was a minimum of 34 correct responses in the 36 test trials. If a participant did not meet this criterion on their transfer-of-function test session they were run through the test a second time, and a third time if necessary. Participants who failed to meet the criterion on a third testing session were dropped from further participation in the study as they had not demonstrated the formation of 'true' functional stimulus classes according to the criteria outlined by Dougher and Markham (1994, 1996).

Phase 4: MTS Equivalence Training. Participants were exposed to an MTS procedure designed to establish two 3-member equivalence classes from the six stimuli in each functional stimulus class in a between-subjects design. While research findings have been inconclusive as to which method, one-to-many or many-to-one, is the most effective for establishing stimulus equivalence classes, (e.g., Arntzen & Holth, 1997; Barnes, 1994; Hove, 2003; Smeets & Barnes-Holmes, 2005), a one-to-many (OTM) training structure was selected for matching-to-sample equivalence training.

The instructions for Phase 4 Equivalence Training appeared on screen as follows:

> "In a moment some images will appear on this screen. Your task is to look at the image at the top of the screen and then at the two images at the bottom of the screen. You should choose one of these two images at the bottom of the screen by placing the mouse cursor on top of it and clicking the mouse button. So, if you want to choose the image on the left, click on the image on the

left. If you want to choose the image on the right click on the image on the right. If you have any questions please ask the experimenter now."

A sample stimulus appeared at the top of the screen and one second later two comparison stimuli appeared in the bottom corners of the screen, one to the left and the other to the right. Feedback (i.e., either the typed words Correct or Wrong) was delivered in red Times 32-point via the computer screen for 2 s following a response. A-B and A-C relations were trained simultaneously, with all trials interspersed in a quasi-random order. There were 16 trials in each training block in Equivalence training, four trial types which were presented four times each in a quasi-random order. In the Aversive Stimulus Condition the four trial types were A1-*B1*/B2, A2-B1/*B2*, A1-*C1*/C2, and A2-C1/*C2* (where italicised comparisons indicate a correct choice). The four trial types in the Neutral Stimulus Condition were A3-*B3*/B4, A4-B3/*B4*, A3-*C3*/C4, and A4-C3/*C4* (see Table 2).

In the present experiment the criterion for passing Equivalence Training was that participants had to respond correctly to all 16 trials within a block of training trials in order to proceed to the Equivalence Test phase. In both conditions participants were exposed to blocks of training trials until they met the response criterion. Participants could not proceed to the test phase until they passed the Equivalence Training phase. Participation in the experiment was terminated for those participants who did not pass equivalence training after 10 trial blocks (160 training trials).

Phase 5: Equivalence Testing. Equivalence testing involved a similar format to Equivalence training with a between-subjects design. However, no feedback was provided to the participants during this phase. This phase probed for combined symmetry and transitivity (i.e., B-C and C-B relations; see Table 2).

The instructions for Phase 5 Equivalence testing were as follows:

"In a moment some images will once again appear on this screen. Your task is to first look at the image at the top of the screen and then at the two images at the bottom of the screen. As before, you should choose one of these two images at the bottom of the screen by placing the mouse cursor on top of it and clicking the mouse button. During this stage you WILL NOT receive feedback on your choices. However, it is important that you continue to make as many correct choices as possible. As before, if you want to choose the image on the left, click on the image on the left. If you want to choose the image on the right click on the image on the right. If you have any questions please ask the experimenter now."

As in Equivalence Training there were 16 trials in each testing block with the four trial types repeated four times each in a quasi-random order. The four probes testing for the emergence of stimulus equivalence classes in the Aversive Stimulus Condition were B1-*C1*/C2, B2-C1/*C2*, C1-*B1*/B2, and C2-B1/*B2* (where the italicised comparison indicates the correct choice). In the Neutral Stimulus Condition the four probes tested were B3-*C3*/C4, B4-C3/*C4*, C3-*B3*/B4, and C4-B3/*B4*. The criterion for passing the Equivalence Test was 16 correct responses within a block of 16 test trials (i.e., 100% correct response rate).

Table 2. Trained and tested relations during MTS training (Phase 4) and Equivalence Testing (Phase 5) across the two conditions. The underlined comparison indicates the correct choice.

	Phase 4 MTS Training	*Phase 5 Equivalence Test*
Aversive Stimulus Condition	A1-<u>B1</u>/B2	B1-<u>C1</u>/C2
	A2-B1/<u>B2</u>	B2-C1/<u>C2</u>
	A1-<u>C1</u>/C2	C1-<u>B1</u>/B2
	A2-C1/<u>C2</u>	C2-B1/<u>B2</u>
Neutral Stimulus Condition	A3-<u>B3</u>/B4	B3-<u>C3</u>/C4
	A4-B3/<u>B4</u>	B4-C3/C4
	A3-<u>C3</u>/C4	C3-<u>B3</u>/B4
	A4-C3/<u>C4</u>	C4-B3/<u>B4</u>

The Equivalence Test was presented immediately upon reaching the training criterion. The experimental software automatically terminated the test phase if the participant did not meet the criterion within 10 blocks of trials (i.e., after 160 trials). The software also recorded the number of blocks of trials required for each participant to reach criterion responding during equivalence testing.

Results

Transfer-of-Function Test

All participants met the criterion of a minimum of 18 correct responses out of 20 test trial probes during their first exposure to Phase 2 Operant Functions Test and progressed to the transfer-of-functions testing phase of the experiment. Twelve of the 57 participants (P19, P21, P25, P26, P28, P29, P36, P38, P42, P51, P53, and P55) failed to meet the predetermined mastery criterion of 34 correct responses out of 36 trials in Phase 3 Transfer-of-Function Test. Of the 45 participants who demonstrated transfer-of-functions, 26 met the criterion on their first exposure to Phase 3 testing while 13 participants required two exposures to the Transfer-of-Function Test. A further six participants (P11, P15, P30, PS35, P37, and P40) required the maximum permitted number of exposures to the Transfer-of-Function Test (i.e., 3 exposures) to reach a minimum of 34 or more correct responses out of the 36 test trials. All data are summarised in Table 3.

Equivalence Training

Forty-five participants proceeded to Phase 4 Equivalence Training. Twenty-one of the 22 participants who underwent equivalence training in the Neutral Stimulus Condition met the required performance criterion within 10 blocks of training trials (i.e., 160 trials). Participant P7 did not meet the criterion within the permitted 10 training blocks and did not progress to Phase 5 Equivalence Testing. All remaining 21 participants met the criterion within seven trial blocks. The mean number of training blocks to criterion was 3.62 with a range of two to seven blocks. Twenty-one of the 23 participants exposed to equivalence training in the Aversive Stimulus Condition met the predetermined performance criterion, with participants P39 and P53 failing to reach the required mastery level of performance within 10 training blocks. Thus, participants P39 and P53 did not progress to the equivalence test phase of the experiment. The mean number of training blocks to criterion for the remaining 21 participants was 5.62 with a range of two to 10 blocks (see Table 3). Participant P45 met the criterion on the tenth block of training trials and thus proceeded to Phase 5 Equivalence Testing.

Equivalence Testing

Forty-two participants were exposed to Phase 5 Equivalence Testing, 21 in each of the two conditions. Eighteen of the 21 participants in the Neutral Stimulus Condition formed the required stimulus equivalence classes within 10 blocks of test trials. Testing was terminated for participants P6, P8, and P 16 after they failed demonstrate stimulus equivalence class formation following the tenth block of test trials (i.e., 160 test trials). The remaining 18 participants required five blocks of test trials or fewer to meet the performance criterion (i.e., 16 correct responses within a block of 16 test trial probes). The mean number of test blocks to criterion in the Neutral Stimulus Condition was 3.05 with a range of one to 10 blocks (see Figure 1).

Fourteen of the 21 participants in the Aversive Stimulus Condition formed the expected stimulus equivalence classes within the permitted 10 blocks of test trials. Participants P33, P35, P41, P45, P46, P48, and P50 did not derive the required stimulus equivalence classes and testing was terminated for these seven participants after the tenth block of test trials. The remaining 14 participants met the criterion within six test blocks (i.e., 96 test trial probes). The mean number of blocks to criterion in Phase 5 Equivalence Testing in the Aversive Stimulus Condition was 5.10 with a range of one to 10 blocks (see Figure 1). As expected, more participants failed to produce stimulus equivalence in the Aversive Stimulus condition than in the Neutral Stimulus condition.

Table 3. Performances of the 57 participants across phases 2 (Operant Function Test), 3 (Transfer-of-Function Test), 4 (Equivalence Training), and 5 (Equivalence Test). See Note below table for legend.

Condition	Partcpt	Phase 2 Test	Phase 3 Transfer of Function Test	Phase 4 MTS Training	Phase 5 Equivalence Test
Neutral Stimulus Condition	P1	20/20	36/36	2	1
	P2	20/20	36/36	2	1
	P3	20/20	29/36; 36/36	2	1
	P4	20/20	36/36	6	1
	P5	20/20	32/36; 36/36	4	2
	P6	19/20	36/36	3	10 F
	P7	20/20	32/36; 34/36	10 F	-
	P8	20/20	36/36	4	10 F
	P9	20/20	36/36	2	1
	P10	20/20	34/36	2	2
	P11	20/20	31/36; 30/36; 34/36	8	2
	P12	19/20	35/36	2	4
	P13	20/20	36/36	5	1
	P14	20/20	36/36	7	5
	P15	20/20	30/36; 29/36; 34/36	3	2
	P16	18/20	36/36	3	10 F
	P17	20/20	35/36	5	1
	P18	20/20	36/36	2	1
	P19	20/20	24/36; 24/36; 28/36	-	-
	P20	20/20	33/36; 36/36	3	3
	P21	19/20	28/36; 28/36;29/36	-	-
	P22	20/20	36/36	4	1
	P23	20/20	35/36	4	4
	P24	20/20	36/36	3	1
				M = 3.91	*M = 3.05*
Aversive Stimulus Condition	P25	20/20	1/36; 5/36; 5/36	-	-
	P26	20/20	32/36; 32/36; 33/36	-	-
	P27	20/20	36/36	7	1
	P28	20/20	22/36; 21/36; 22/36	-	-
	P29	20/20	29/36; 30/36; 31/36	-	-
	P30	20/20	31/36; 29/36; 34/36	3	3
	P31	20/20	32/36; 34/36	9	5
	P32	20/20	32/36; 34/36	8	2
	P33	20/20	33/36; 35/36	5	10 F
	P34	20/20	34/36	3	5
	P35	20/20	29/36; 32/36; 34/36	9	10 F
	P36	20/20	27/36; 30/36; 29/36	-	-
	P37	20/20	31/36; 33/36; 34/36	3	2
	P38	20/20	31/36; 31/36; 31/36	-	-
	P39	20/20	22/36; 34/36	10 F	-
	P40	20/20	31/36; 33/36; 34/36	2	4
	P41	20/20	35/36	9	10 F
	P42	20/20	29/36; 25/36; 28/36	-	-
	P43	20/20	32/36; 34/36	6	2
	P44	20/20	33/36; 36/36	4	1
	P45	18/20	31/36; 34/36	10 P	10 F
	P46	20/20	31/36; 34/36	8	10 F
	P47	19/20	35/36	5	6
	P48	19/20	32/36; 34/36	8	10 F
	P49	20/20	35/36	3	1
	P50	20/20	34/36	5	10 F
	P51	18/20	30/36; 32/36; 32/36	-	-
	P52	20/20	34/36	10 F	-
	P53	18/20	31/36; 32/36; 31/36	-	-
	P54	20/20	36/36	2	2
	P55	20/20	29/36; 28/36; 29/36	-	-
	P56	19/20	36/36	4	1
	P57	20/20	35/36	5	2
				M = 6.0	*M = 5.10*

Note: Partcpt = Participant number; Phase 2 Test = Phase 2 Operant Function Test number of correct trial responses; Phase 3 Transfer of Function Test = Phase 3 Transfer of Function Test number of correct trial responses; Phase 4 MTS Training = Phase 4 Equivalence Training number of trial blocks to criterion; Phase 5 Equivalence Test = Phase 5 Equivalence Test number of test blocks to reach mastery criterion. *M* = Mean number of blocks-to-criterion.

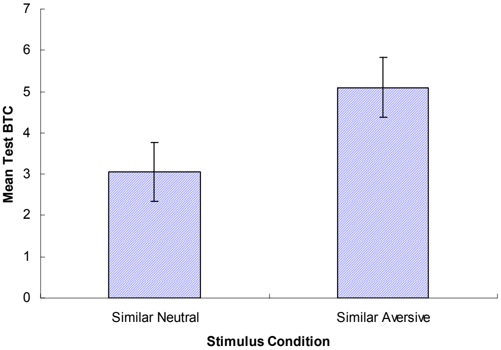

Figure 1. Mean Blocks-to-criterion (BTC) in Phase 5 Equivalence Test in both stimulus conditions, Aversive Stimulus class and Neutral Stimulus class.

Statistical Analysis

An independent *t*-test (two-tailed) was performed to examine if there was a difference between the Aversive and Neutral Stimulus conditions in terms of the number of blocks-to-criterion required in Phase 4 Equivalence Training. Participants required significantly more blocks of training trials to meet criterion in the Aversive Stimulus Condition, t (43) = 3.178, p = .003, compared to the Neutral Stimulus Condition.

A further independent *t*-test (one-tailed) was performed to compare the number blocks of equivalence testing required for participants to reach criterion in the Aversive Stimulus and Neutral Stimulus conditions. There was a significant effect for condition, t (40) = 1.902, p = .032 (one-tailed), with participants requiring significantly more blocks of test trials to derive the expected stimulus equivalence relations in the Aversive Stimulus Condition than in the Neutral Stimulus Condition. Furthermore, a chi-square test of association was conducted to examine differences in the probability of successfully demonstrating the formation of stimulus equivalence classes within 10 testing blocks across the two conditions. While fewer participants produced stimulus equivalence relations to criterion in the Aversive Stimulus Condition than in the Neutral Stimulus Condition, this difference was not significant (X^2 (1) = 2.1, p > .05).

Discussion

In the present study, participants required more blocks of both training and testing to form stimulus equivalence classes when the stimuli employed had similar aversive functions compared to when these stimuli shared similar emotionally neutral functions. It appears, therefore, that functional classes of aversive stimuli are not easily re-organised into stimulus equivalence classes.

These findings extend those of Tyndall et al. (2004). In that study, it was shown that while controlling for the emotional valence of stimuli, the existence of a functional class alone was a sufficient condition for an interfering effect on subsequent stimulus equivalence class formation. More specifically, that study showed that functional classes of salient but non-emotional stimuli are difficult to re-organise into stimulus equivalence classes compared to sets of stimuli that do not participate in a functional class. In contrast, the present study has shown using a rigorous test that both stimulus sets across both experimental conditions formed functional classes. Nevertheless, an "interference effect" was still observed for the aversive stimulus set compared to the neutral stimulus set.

Of course, it may be the case that interference in stimulus equivalence class formation was observed here in the Neutral Stimulus Condition. However, in the absence of a third condition consisting of stimuli that do not have shared functions, this is difficult to confirm. In any case, the outcome of such a condition would not add to or detract from the current substantive finding that shared emotional valence alone is sufficient to disrupt equivalence class formation. This is an important extension of the Tyndall et al. (2004) study, which showed that mere shared function among stimuli alone is also a sufficient condition to disrupt equivalence class formation. In effect, while both shared function and high emotional valence constitute sufficient conditions to produce a stimulus equivalence interference effect, neither factor now appears to be more necessary than the other as the presence of only one is necessary.

It is rather easy to speculate on why pre-existing functional classes might interfere with the formation of stimulus equivalence classes. Where a functional class has been formed, by definition, a history has been provided in which common consequences were presented upon the presentation of, or following a response to any and each of an array of stimulus objects. By the very nature of what we mean by a class of stimuli, there is no discrimination required between the stimulus objects that constitute the class. All that is required is that the stimulus array be discriminable from non-class members, at least in the experimental context. When an experimenter subsequently requires an individual to parse the stimulus array into two distinct equivalence classes, they are juxtaposing equivalence training contingencies which require stimulus discrimination, with those contingencies governing the formation of the functional class, which required (by definition) the individual not to discriminate between stimulus objects in the stimulus array. Not surprisingly, this simple juxtaposition of contingencies should create behavioural competition, and it should require extended exposure to the stimulus equivalence training contingencies for the previously reinforced non-discrimination of objects in a stimulus array to be over-ridden.

The foregoing process (behavioural competition) may well explain both the Plaud (1995, 1997) and the Leslie et al. (1993) effects. However, in light of the current findings we now cannot be so sure. It now appears that the findings of those studies may indeed be at least partially attributable to the fact that the stimuli employed were high in emotional valence. Indeed, this is precisely what the authors themselves suspected, although no process account for this effect has been offered.

Plaud (1995, 1997) explained his reported effects in terms of the meaningfulness of the real-world stimuli employed. That is, to a snake phobic, for instance, snake stimuli are more meaningful than flower stimuli (i.e., more potent and laden with a greater number of stimulus and response functions). Such an account may well point us in the direction of one explanation, insofar as "meaning" is increasingly being understood by behaviour analysts to involve the formation of stimulus equivalence and other derived relations between stimuli (e.g., Barnes, 1994; Dickins, 2001; Dougher, 1998; Dymond & Rehfeldt, 2000; Hayes, et al., 2001; Hayes & Wilson, 1993). That is, a stimulus can be said to have a meaning to the extent that it functions as a symbol. To respond to a stimulus symbolically is to respond to that stimulus in terms of another stimulus; in other words relationally (Green & Saunders, 1998; Sidman, 1990; Wilkinson & McIlvane, 2001).

To this extent, pre-existing derived relations between stimuli (e.g., all snakes) should indeed compete with contingencies that require an individual to parse these stimuli into distinct equivalence classes. However, the current study has shown that any acceptable level of demonstrable "meaning" is not required to produce a stimulus interference effect, insofar as this effect was generated here using a respondent process and using simple nonverbal stimuli to form the relevant functional classes. Of course, verbal processes may well have been at work, insofar as human verbally-able subjects may always verbalise the stimulus relations to which they respond, thereby forming equivalence and other relations among stimuli (e.g., Dougher, et al., 2007; Dymond & Rehfeldt, 2000; Dymond, et al., 2007; Forsyth & Eifert, 2008; Hayes, et al., 2001; Hayes, et al., 1999). At present, however, this is mere conjecture and requires further experimentation. Thus, at present an explanation in terms of "meaningfulness" is simply not satisfactory.

In a later paper, Plaud, Gaither, Franklin, Weller, and Barth (1998) appealed to stimulus salience as an explanation for the "interference effect". What is required, however, is an explanation of *how* the salience of stimuli affects learning in a stimulus equivalence training context. There are three possible processes that should be considered in future research. The first process has already been discussed above and relates to simple behavioral competition between contingencies controlling different forms of class membership with a common stimulus array. The second process, however, might relate to the phenomenon of overshadowing. More specifically, it has been shown that conditioned eliciting stimulus functions can block the acquisition of discriminative operant response functions for that stimulus (see Dinsmoor, 1995). Thus, in the current context, the simultaneous occurrence of an operant response (e.g., choose the comparison B1 given the A1 sample) and a Pavlovian CS (i.e., the respondently conditioned aversive functions of B1) might result in the impeded acquisition of conditional discriminations during equivalence training. Indeed, in the Tyndall et al. (2004) study, impeded conditional discrimination training was not observed in the absence of conditioned aversive functions. This may suggest that overshadowing may have been occurring on a trial-by-trial basis in the present study. However, it is important to understand that even in the absence of conditioned aversive functions, the interference effect reported here is still observed (e.g., Tyndall, et al, 2004). Thus, while overshadowing may have played some role in the creation of the interference effect observed here, it would appear to be insufficient a singular explanation of the effect.

A third possible process that may help to explain the current findings involves the widely observed phenomenon of *attention bias.* This phenomenon refers to the observation that the conditioned aversive stimulus functions of discriminative stimuli can interfere with observing behavior, thereby negatively impacting on the efficient acquisition of stimulus discriminations. Put simply, subjects reliably pay more attention to threat stimuli that non-threat stimuli (e.g., Kindt & Brosschot, 1997; Mathews & MacLeod, 1994; Thorpe & Salkovskis, 1997, 1998; Valdivia-Salas, Forsyth, & Luciano, 2009; Williams, Mathews, & MacLeod, 1996; Wray, et al., 2009). Increased attention to threat stimuli, thus, could reasonably be expected to impede discrimination learning during equivalence training, as was observed here. However, as an interpretive explanation at this point, this suggestion requires further experimental investigation. In addition, we would remind the reader once again that the current observed interference effect reliably occurs in the absence of threat stimuli. Thus, while the use of threat stimuli itself may impede conditional discrimination learning, attention bias cannot be easily used as a single explanation for the current effects.

While appealing to attention bias has some appeal, in fact such an explanation may also appear somewhat counterintuitive. More specifically, the salience of stimuli (emotional or otherwise) is usually thought to aid rather than hinder the learning process (e.g., Miller & Escobar, 2002). It does appear, however, from the current findings, that stimuli which pose threat, or are discriminative for avoidance, may constitute exceptions to the general observation that stimulus salience aids learning. Future research can further explore this issue by comparing the effects of aversive stimuli, with other equally emotionally salient non-aversive stimuli on the formation of stimulus equivalence classes.

It must be acknowledged that while shared aversive stimulus functions significantly increased the number of training and testing blocks required to form stimulus equivalence, differences in the *probability* of equivalence class formation were not significant. Thus, the significant difference in *rates* of equivalence class formation across both conditions should be interpreted with caution. Of course, it should be noted also that as an analogue study the stimuli employed here were necessarily relatively innocuous (i.e., for ethical reasons). It is probable, therefore, that even greater interference effects in equivalence class formation would be observed in a clinical population employing phobic stimuli or under conditions where the emotional valence of experimental stimuli could be enhanced.

One implication of the present study for understanding human anxiety relates to difficulties that may arise in the employment of cognitive restructuring techniques in treating persons with anxiety disorders (e.g., Beck, 1993; Beck, Emery, & Greenberg, 1985; Ellis, 2001). As we have suggested previously, when a set of stimuli that belong to a functional stimulus class are employed in a matching-to-sample paradigm that requires these stimuli to be differentially discriminated we can expect to see delays in the acquisition of the relevant conditional discrimination as well as in the emergence of stimulus equivalence. Thus, we should also expect functional classes of aversive stimuli for anxious clients to be resistant to restructuring.

For example, for a spider phobic, actual spiders and words such as “cobwebs”, “venomous”, “creeping”, “lurking”, and “hairy legs”, may all be functionally similar insofar as they occasion the same avoidance response. They, therefore, can be said to form a functional class of aversive stimuli. Any attempt to parse this functional class into, let’s say, venomous and non venomous spiders, is likely to require a special effort. This example is apt, because cognitive restructuring might reasonably involve attempting to do precisely this in an effort to “reality test” the client in terms of their beliefs about (for instance) the fatal or near fatal consequences of contact with spiders. Ultimately, the cognitive therapist is attempting to teach the client that not all spiders are dangerous and that it is adaptive to be fearful of some spiders but not all. At the very least the therapist may simply be attempting to reduce the size of the stimulus class that controls avoidance to a small and infrequently encountered set of stimuli (e.g., Amazonian spiders for a spider phobic that lives in Denmark).

The current data suggest, however, that such cognitive restructuring techniques which aim to teach new relationships among feared stimuli may meet with difficulty or even failure. Such efforts will be particularly difficult when functional stimulus classes are well-established over a long period of time. Appropriately, Wilson, Hayes, Gregg, and Zettle (2001) suggested that for verbally-able humans verbal processes “glue together” (p. 216) stimuli and their attendant functions through the bi-directional transfer of stimulus functions. Put simply, it is this “stickiness” that holds a functional stimulus class together particularly strongly for a verbally-able human compared to a non-verbal organism, and it is may be this increased class strength that makes it difficult to re-arrange these verbal relations in therapy.

Interestingly, for largely the foregoing reasons, Acceptance and Commitment Therapy (ACT; Hayes, Luoma, Bond, Masuda, & Lillis, 2006; Hayes & Smith, 2005; Hayes, et al., 1999) does not attempt to restructure or alter problematic derived relations among aversive stimuli. Instead, it attempts to establish a variety of new responses to aversive stimuli (i.e., additional response functions) that compete with avoidance functions. In addition, it attempts to alter the context for the derived transfer of avoidance functions, rather than eliminate the derived avoidance altogether. For instance, a widely used ACT technique known as defusion (see Masuda, Hayes, Sackett & Twohig, 2004) is viewed as altering the context for the derived transformation of avoidance functions, while leaving the relevant verbal relations intact (see Blackledge, 2007). Thus, the aim is to alter the response functions of thoughts and other private events, rather than trying to alter their form, frequency or situational sensitivity (Hayes & Wilson, 1994). The findings of the current study may provide some empirical support for such a strategy as an alternative to cognitive restructuring.

Dougher et al. (2007) suggested that one significant challenge for behavior analysts is to identify and provide experimental evidence for behavioral processes that can replace the notion of cognitive structures (e.g., beliefs, schemas, expectancies) in cognitive therapy and explain clinically relevant behaviour in functional terms (p. 155). More basic empirical research, such as the present study, and applied studies in clinical settings with clinical populations, is needed to advance our understanding of the relationship between functional stimulus class formation, stimulus equivalence, transfer-of-function, and derived relational responding more generally. These very questions may well prove to be our most promising in terms of developing modern functional-analytic accounts of the emergence and treatment of clinical anxiety.

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