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TRANSFORMATION OF AVOIDANCE RESPONSE FUNCTIONS IN ACCORDANCE WITH SAME AND OPPOSITE RELATIONAL FRAMES

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Research on the emergence of human avoidance behavior in the absence of direct contact with an aversive event is somewhat limited. Consistent with work on derived relational responding, the present study sought to investigate the transformation of avoidance response functions in accordance with the relational frames of Same and Opposite. Participants were first exposed to nonarbitrary and arbitrary relational training and testing in order to establish Same and Opposite relations among arbitrary stimuli. The training tasks were; Same–A1–B1, Same–A1–C1, Opposite–A1–B2, Opposite–A1–C2. Next, all possible combinatorially entailed (i.e., B–C and C–B) relations were tested. During the avoidance-conditioning phase, one stimulus (B1) from the relational network signaled a simple avoidance response that cancelled a scheduled presentation of an aversive image and sound. All but one of the participants who met the criteria for conditioned avoidance also demonstrated derived avoidance by emitting the avoidance response in the presence of C1 and the nonavoidance response in the presence of C2. Control participants who were not exposed to relational training and testing did not show derived avoidance. Implications of the findings for understanding clinically significant avoidance behavior are discussed.

Key words: avoidance, transformation of functions, same, opposite, relational frame theory, human adults

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Avoidance refers to negatively reinforced behavior in which a response prevents the onset of an aversive stimulus, and as a result becomes more likely to reoccur (Catania, 1998). Avoidance behavior has been widely studied with nonhumans and has led to the development of several theories to account for the acquisition and maintenance of directly established avoidance (e.g., Dinsmoor, 2001; Herrnstein & Hineline, 1966; McAllister & McAllister, 1991; Sidman, 1966). Real-world avoidance is typically, but not always, preceded by an instance of direct aversive conditioning, and in early behavior therapy it was customary to conceptualize both the acquisition and treatment of fear and avoidance based on Pavlovian conditioning (e.g., Wolpe & Rachman, 1960). According to this view, any previously neutral stimulus paired with an unconditioned stimulus (UCS) capable of eliciting an unconditioned response (UR) will come to function as a conditioned stimulus (CS) capable of eliciting a conditioned response (anxiety or fear) similar to the UR. Pavlovian models of aversive conditioning may be challenged, however, particularly in explaining cases where the acquisition and maintenance of clinical fears cannot be traced to a readily identifiable traumatic experience with an environmental event (e.g., Rachman, 1977, 1991). Indeed, explaining the etiology of fear and avoidance acquired without a history of aversive conditioning with regard to the feared object or event represents a challenge to all conditioning accounts (cf. Field, 2006).

Recently, it has been argued that language and verbal processes represent a neglected but critical dimension in explaining the etiology of avoidance behavior in cases where an aversive event is either extremely remote or has only been experienced indirectly (e.g., Forsyth & Eifert, 1996; Forsyth, Eifert, & Barrios, 2006; Hayes, 2004; Marks, 1981, 1987). For instance, when a snake-phobic client hears the word ‘‘snake’’ and experiences an alarm response, not only is it likely that the word ‘‘snake’’ will

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function as a CS, but it also is likely that other stimuli that are topographically different from the sound of the word ''snake'' (pictures of snakes, actual snakes and places where snakes may be found) often acquire similar functions. In fact, a growing literature exists in which stimulus functions may be shown to transfer through indirectly related stimuli in the absence of direct conditioning (Dymond & Rehfeldt, 2000; Forsyth, 2000; Friman, Hayes, & Wilson, 1998; Wilson & Blackledge, 2000). Indeed, a previous study by Augustson and Dougher (1997) demonstrated that human avoidance responses can be evoked by stimuli solely on the basis of their participation in equivalence relations with conditioned aversive stimuli. Specifically, Augustson and Dougher showed a transfer or transformation[1] of avoidance response functions through equivalence relations. These authors first trained and tested participants for the emergence of two 4-member equivalence classes (i.e., A1–B1–C1–D1, A2–B2–C2–D2). Using a baseline Pavlovian conditioning procedure, one member of one class was paired with shock (B1) while one member of the other class was presented without shock (B2). A differential, signaled avoidance task was then introduced wherein shock was avoided if a participant made a key pressing response to the stimulus previously associated with shock. The remaining stimuli from both classes then were presented, but in the absence of shock. Consistent with predictions, stimulus presentations from the ''aversive class'' (i.e., A1–B1–C1–D1) evoked avoidance responses, whereas stimulus presentations from the ''nonaversive class'' (i.e., A2–B2–C2–D2) did not. All participants showed evidence of this differential transformation of avoidance-evoking functions to all members of the aversive class, but not to the nonaversive class. This study was the first to show the emergence of avoidance responding to stimuli that had no direct relational history with aversive events, and thus helps to explain how avoidance behaviors may develop in the absence of direct aversive conditioning.

It is important to note that equivalence relations represent just one of several derived relations that might occur between stimuli and events. Thus, there are likely many more ways for derived avoidance responses to emerge in the world outside the laboratory, in addition to those suggested by Augustson and Dougher's (1997) equivalence-based account. Several studies conducted under the rubric of relational frame theory have provided evidence that it is possible for humans to respond in accordance with relations other than equivalence, such as same and opposite (Dymond & Barnes, 1996; Roche & Barnes, 1997; Steele & Hayes, 1991; Whelan & Barnes-Holmes, 2004) and more-than/less-than (Berens & Hayes, 2007; Dymond & Barnes, 1995; O'Hora, Roche, Barnes-Holmes, & Smeets, 2002; Reilly, Whelan, & Barnes-Holmes, 2005; Whelan, Barnes-Holmes, & Dymond, 2006). These other stimulus relations or relational frames yield different patterns of responding than those seen in research on equivalence relations. For instance, equivalence always yields the same derived relations across related pairs of stimuli (if A is equivalent to B and B is equivalent to C, then A and C are also equivalent). Opposition relations, however, do not always yield the same derived relations (if A is the opposite of B and B is the opposite of C, then A and C are the same, not opposite).

To date, several studies have demonstrated a transformation of self-discriminative (Dymond & Barnes, 1996), sexual arousal (Roche & Barnes, 1997), and consequential (Whelan & Barnes-Holmes, 2004) functions in accordance with the relational frames of Same and Opposite. It remains to be seen whether a transformation of avoidance-response functions also may be demonstrated with Same and Opposite relational frames. Such a demonstration would help to explain how avoidance behavior occurs in the absence of simple aversive conditioning. For instance, it is widely known that persons suffering from anxiety disorders show pervasive patterns of avoidance behavior that extend well beyond events that might be construed in terms of direct traumatic conditioning (Barlow, 2002).

The present study sought to extend Augustson and Dougher's (1997) equivalence-based analysis of derived avoidance by examining if it

[1] The term ''transformation of functions'' is often used as a generic alternative to ''transfer'' because it encapsulates changes in stimulus function that accrue when relations other than equivalence are involved. Consistent with this, we will adopt the term ''transformation of functions'' throughout the present paper (see Barnes-Holmes, Hayes, Dymond & O'Hora, 2001; Dymond & Rehfeldt, 2000).

is possible for avoidance responses to emerge for novel stimuli by virtue of their participation in the relational frames of Same and Opposite. Participants were exposed to nonarbitrary and arbitrary relational training and testing to establish a relational network of same and opposite stimuli. Next, using a novel avoidance conditioning procedure, one stimulus from the network signaled a simple avoidance response. Finally, a test for transformation of avoidance-response functions was presented.

METHOD

Participants

Twelve participants, aged between 21 and 38 years, were recruited via bulletin board announcements or personal contacts from the student community at the University of Wales, Swansea and participated in return for either course credit or £7. Three participants (P10, P11, and P12) served as Control participants. All procedures received prior ethics review approval.

Materials

A computer program written in Visual Basic® 6.0 controlled all stimulus presentations and recorded all responses. Visual and auditory stimuli were selected from the *International Affective Picture System* (*IAPS;* Lang, Bradley, & Cuthbert, 2005) and the *International Affective Digitized Sounds* (*IADS*; Bradley & Lang, 1999) for use as aversive and nonaversive stimuli during the avoidance conditioning and transformation testing phases. The *IAPS* and *IADS* are a collection of normative emotional stimuli widely used in experimental research. A total of 20 photographs, 10 aversive (e.g., bodily mutilations) and 10 nonaversive (e.g., landscapes), and 10 aversive sounds (e.g., a female screaming) were selected[2].

Two stimuli in ''Wingdings'' font were used as contextual cues for Same (i.e., ♓) and Opposite (i.e., ♑), respectively. Eight nonsense syllables were employed as sample and comparisons during relational training and testing (i.e., CUG, JOM, ZID, PAF, MEL, LEB, VEP, FIH). These are labeled, for the purposes of clarity, using the alphanumerics A1, B1, C1, B2, C2, N1, N2, and N3.

Procedure

General procedure. On arrival at the laboratory, participants signed a consent form acknowledging the distasteful nature of some of stimuli to be used during the experiment and indicating that they did not have a history of clinical problems. Next, participants were seated comfortably at a table in front of a computer in a small experimental room. The experiment began with the following instructions displayed on the computer screen:

> Thank you for agreeing to participate in this study. You will be presented with a series of images or nonsense words on the top half of the screen from left to right. Then you will be presented with 5 images or nonsense words on the bottom of the screen. Your task is to observe the images or words that appear from left to right and drag one of these images or words from the bottom to the blank, yellow square. Click and hold the mouse over the image or word to drag it to the blank square. To confirm your choice, click 'Finish Trial'. If you wish to make another choice, then click 'Start Again'. Sometimes you will receive feedback on your choices, but at other times you will not. Your aim is to get as many tasks correct as possible. It is always possible to get a task correct, even if you are not given feedback.

Clicking on a check box at the bottom of the screen cleared the instruction screen and, after a 3-s interval, Phase 1 commenced.

During all nonarbitrary and arbitrary relational training and testing phases the computer screen was divided into two areas, the top two thirds was blue, the remainder gray. The sample appeared on the left upper portion of the screen, after 1 s the contextual cue appeared in the upper center, and after a further 1 s a ''blank'' comparison square appeared 1 s later on the right upper portion of the screen. Five comparison stimuli appeared simultaneously on the lower section of the screen. The location of the comparison stimuli across the bottom of the screen was randomized across trials.

Across all phases, the Relational Completion Procedure (see below) was used to train and test the derived relations. The first two phases

[2] IAPS and IADS identifiers: (Pictures) # 3000, # 3010, # 3030, # 3051, # 3060, # 3061, # 3062, # 3063, # 3064, # 3068, # 1333, # 1811, # 1812, # 1999, # 2791, # 2840, # 5260, # 5480, # 5300, & # 1731; (Sounds) # 276, # 277, # 278, # 279, # 285, # 286, # 290, # 292, # 380, & # 423.

consisted of nonarbitrary relational training and testing designed to establish contextual cues for generalized Same and Opposite responding. The third phase involved arbitrary relational training during which participants were trained to relate a series of arbitrary stimuli (i.e., nonsense syllables) in the presence of the SAME and OPPOSITE cues to establish a contextually controlled relational network of arbitrary stimuli. The fourth phase involved arbitrary relational testing and was used to probe for the emergence of derived relations among the arbitrary stimuli in the network.

The contextual cues were arbitrary symbols, whereas the samples and comparisons were either nonarbitrary (i.e., formally related) or arbitrary (i.e., formally unrelated) stimuli, depending on the specific phase. The Relational Completion Procedure requires participants to drag one of the five comparisons into the blank comparison square. This was done by placing the cursor over the comparison and holding down the left mouse button. Moving the cursor over the blank square and releasing the left mouse button moved the selected comparison into the ''blank'' comparison square. The comparison stimulus that was moved was itself simultaneously replaced by a blank yellow square.

When the comparison was dropped, two buttons appeared on the bottom of the screen that displayed the captions 'Finish Trial' and 'Start Again', respectively. Hovering the cursor over the Finish Trial button produced a small text box with the caption ''Click here to finish this trial,'' and hovering over the Start Again button produced the text ''Click here to start again.'' Pressing the Start Again button reset all the stimuli to where they were before the comparison was dropped (i.e., the comparison square on the upper portion of the screen became blank and the selected comparison returned to the lower portion of the screen). Pressing the Finish Trial button cleared the screen and produced the feedback screen during the training phases and the intertrial interval (ITI) during test phases. During the ITI, which was 3 s in duration, all stimuli were cleared from the screen and the background color remained blue. During the feedback screen, a yellow box surrounded the sample, the contextual cue, and the selected comparison from the previous trial. If the participant made the correct selection, the word ''Correct'' was displayed below the yellow box in black font on a yellow background and a beep was presented; otherwise the word ''Wrong'' was displayed in the same format.

Table 1

Stimulus sets employed during the nonarbitrary relational training (Phase 1) and testing (Phase 2) phases. Also shown are the physical endpoints of the each stimulus set, which were used to train contextual functions of Same and Opposite.

	Physical dimension	
Description	End 1	End 2
Phase 1		
Red disk sections	Thin crescent	Full disk
Lines	Short	Long
Cubes	Small	Big
Smiley faces	Very sad	Very happy
Dots	Few	Many
Trees	Small	Big
Phase 2		
Buildings	Small	Big
Wavy lines	Small amplitude	Big amplitude
Columns	Narrow	Wide
Snowstorm	No snow	White-out
Bowed trees	Straight	Very bowed
Pointed star	Three-points	Twenty-points

Phase 1: Nonarbitrary relational training. During this phase, all the samples and comparisons were related to each other along a nonarbitrary dimension (e.g., size). For example, if a small cube was presented as the sample, then in the presence of the OPPOSITE contextual cue, choosing the comparison that was furthest along the physical dimension of size was reinforced. Alternatively, if a small cube was presented as the sample, then in the presence of the SAME contextual cue, choosing the comparison that was the same physical size as the sample was reinforced. The samples and comparisons were all pictures of common objects or shapes. There were six stimulus sets (see Table 1) presented in a purely random order. When participants produced eight consecutively correct responses they were immediately exposed to Phase 2.

Phase 2: Nonarbitrary relational testing. This phase followed the same format as Phase 1, with two exceptions: no feedback was presented (responses were simply followed by the ITI), and six novel stimulus sets were employed (see Table 1). Participants were required to respond correctly across all eight trials in order to immediately proceed to Phase

3; failure to do so resulted in reexposure to Phase 1.

Phase 3: Arbitrary relational training. During this phase the samples and comparison stimuli were all arbitrary stimuli (trigrams). The probes for arbitrary relational training and testing are described using the following convention: The contextual cue is described first in capitals, followed by the sample stimulus, followed by the five comparison stimuli in brackets. The experimenter-designated correct comparison is in italics. For example, the notation SAME/A1 [*B1*–B2–N1–N2–N3] indicates that in the presence of the contextual cue SAME and the sample stimulus A1, selecting B1 was reinforced, whereas selecting B2, N1, N2, or N3 was not. All participants were presented with the following four training trials: SAME/A1 [*B1*–B2–N1–N2–N3], SAME/A1 [*C1*–C2–N1–N2–N3], OPPOSITE/A1 [B1–*B2*–N1–N2–N3], and OPPOSITE/A1 [C1–*C2*–N1–N2–N3]. Training occurred in blocks of eight trials, with each trial type presented twice per block. Participants were required to choose the correct comparison across eight consecutive trials before being immediately exposed to Phase 4.

Phase 4: Arbitrary relational testing. The aim of this phase was to determine if responding in accordance with the derived relations of Sameness and Opposition would emerge. Figure 1 shows the predicted relational network. Responses during test trials were not reinforced and the trial types were as follows: SAME/B1 [*C1*–C2–N1–N2–N3], SAME/C1 [*B1*–B2–N1–N2–N3], SAME/B2 [C1–*C2*–N1–N2–N3], SAME/C2 [B1–*B2*–N1–N2–N3], OPPOSITE/B1 [C1–*C2*–N1–N2–N3], OPPOSITE/C2 [*B1*–B2–N1–N2–N3], OPPOSITE/B2 [*C1*–C2–N1–N2–N3], and OPPOSITE/C1 [B1–*B2*–N1–N2–N3].

Responding in accordance with the predicted relational network required that subjects would (a) choose C1 given B1 in the presence of SAME; (b) choose B1 given C1 in the presence of SAME (C1 and B1 are both the same as A1 and therefore the same as each other); (c) choose C2 given B2 in the presence of SAME; (d) choose B2 given C2 in the presence of SAME (C2 and B2 are both opposite to A1 and therefore the same as each other); (e) choose C2 given B1 in the presence of OPPOSITE; (f) choose B1 given C2 in the presence of OPPOSITE (C2 is opposite to A1,

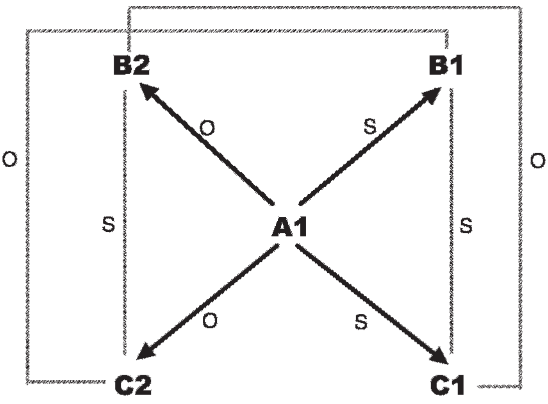

Fig. 1. The network of trained and tested stimulus relations. Alphanumerics represent the nonsense syllables used in training and the letters ''S'' and ''O'' indicate Same and Opposite, respectively. Solid lines indicate trained relations. Dashed lines represent derived relations.

and B1 is the same as A1, and therefore C2 is opposite of B1); (g) choose C1 given B2 in the presence of OPPOSITE; and choose B2 given C1 in the presence of OPPOSITE (C1 is the same as A1, and B2 is opposite to A1, and therefore C1 is opposite to B2).

Testing occurred in a block of 16 trials, with each task presented twice per block. Participants were required to make a minimum of 14/16 (i.e., 87.5%) correct responses in order to pass the arbitrary relational test. If this criterion was not met, they were exposed to this training and testing sequence for a predetermined maximum of four exposures.

Phase 5: Avoidance conditioning. The purpose of this phase was to train a simple avoidance response (pressing the space bar) during the presentation of one stimulus and not during presentations of another stimulus. At the beginning of this phase, participants were given headphones to wear and the following instructions were presented on the screen:

> In a moment, you will be presented with some nonsense words, pictures and sounds. The pictures and sounds are from real life events and may be considered upsetting to some people. Pictures will be presented on the computer screen and sounds will be presented via headphones.
> The pictures and sounds will follow nonsense words. Your task is to learn to cancel certain pictures and sounds before they are presented, by pressing the space-bar.

It is important that you pay attention and concentrate on the screen at all times.
If you have any questions, please ask the experimenter now. Press any key to continue.

Participants began the first avoidance conditioning trial with a key press. Following the ITI, which varied randomly between 10 and 30 s, either the B1 or B2 stimulus appeared in the center of the computer screen for 5 s. If participants pressed the space bar while the stimulus was present, then the screen cleared and the words ''Picture Cancelled'' appeared for 2 s. If participants did not press the space bar, the B1 or B2 stimulus was followed by a 2-s interval, after which either a 600 × 800 pixel photograph and a sound were presented for 2 s (following B1) or a photograph was presented for 2 s (following B2).

Aversive images and sounds followed 75% of the presentations of B1 when the space bar was not pressed (i.e., 75% contingency between B1 and the aversive stimuli). Aversive images and sounds were not presented following the remaining 25% of presentations of B1 when the space bar was not pressed. Nonaversive images followed 75% of the presentations of B2 when the space bar was not pressed (i.e., 75% contingency between B2 and the relief stimulus). Nonaversive images were not presented following the remaining 25% of presentations of B2 when the space bar was not pressed.

The B1 and B2 stimuli were presented in a quasirandom order (i.e., no more than two consecutive exposures to either) until participants had viewed (i.e., not avoided) a minimum of 20 images. Conditioned avoidance was defined as the production of an avoidance response during each of the final 10 consecutive exposures to B1, and the absence of an avoidance response during all of the final 10 consecutive exposures to B2. If a participant failed to demonstrate conditioned avoidance according to these criteria, then the tasks were presented once more. This procedure was adopted in order to ensure that a baseline of avoidance behavior was established prior to the critical transformation test.

Phase 6: Transformation of functions test. Phase 6 began immediately following Phase 5. All participants were given a block of 12 trials involving C1 and C2 presented in a quasirandom order (with no more than two consecutive presentations of either) until each stimulus had been presented six times. Stimuli remained on the screen for 5 s if there was no response. If a participant pressed the space bar during the presentation of either C1 or C2, then the screen cleared and the words ''Picture Cancelled'' appeared on the screen for 2 s. Failure to press the space bar during the presentation of C1 was never followed by an aversive image or sound (i.e., 0% contingency between C1 and the aversive stimuli), whereas failure to press the space bar during the presentation of C2 resulted in a 2 s presentation of the relief stimulus (i.e., a 75% contingency between C2 and the relief stimulus). Thus, nonavoidance responses to C2 were followed (75% of the time) by nonaversive stimuli, but C1 was never followed by aversive images and sounds (i.e., respondent extinction). Following the twelfth trial, a screen appeared with the caption ''this is the end of the experiment, please contact the experimenter now''. A predetermined mastery criterion of canceling upcoming images (i.e., emitting the avoidance response) during at least four of the six presentations of C1 and no more than two of the six presentations of C2 was used in order for the derived transformation of avoidance response functions to be said to have occurred.

Control participants. The 3 control participants were exposed only to Phases 5 and 6 of the experiment. That is, they were not exposed to any of the relational training or testing procedures.

RESULTS

Table 2 shows the performance of participants during Phases 1 to 4. P1, P3, and P7 passed both the nonarbitrary and arbitrary relational tests on their first exposure. P2, P4, P5, and P8 required two exposures to the nonarbitrary and arbitrary relational tests before reaching criterion, and P9 required a total of three exposures. P6 was the only participant to be exposed to the arbitrary relational test four times, during which she failed to achieve criterion.

All participants, except P6 who failed the arbitrary relational test, progressed to the avoidance-conditioning phase. Participants required between 40 and 65 trials ($M = 50$) to meet the criteria for conditioned avoidance (Table 3). Avoidance responses were emitted during virtually all B1 trials and on only one occasion during B2 trials by two participants

Table 2

Number of trials to criterion and percentage correct responses during the nonarbitrary and arbitrary relational training and testing phases (Phases 1–4). [a]indicates a participant who did not achieve criterion on arbitrary relational test.

Participant	Phase 1: Nonarbitrary Relational Pretraining (trials to criterion)	Phase 2: Nonarbitrary Relational Testing (%)	Phase 3: Arbitrary Relational Training (trials to criterion)	Phase 4: Arbitrary Relational Testing (%)
P1	72	100	30	100
P2	17	100	52	56
	8	100	8	87.5
P3	27	100	40	93.75
P4	17	100	25	50
	8	100	15	93.75
P5	8	100	22	81
	8	100	8	100
P6[a]	8	100	45	37.5
	8	100	8	37.5
	9	100	8	43.75
	14	100	8	25
P7	8	100	12	87.5
P8	15	100	58	81
	8	100	8	93.75
P9	9	100	49	81.25
	8	100	8	81.25
	8	100	8	93.75

(P8 and P9). The majority of nonavoidance responses were made during B2 trials and only occasionally during B1 trials. Overall, the avoidance response was quickly acquired and maintained (see Appendix A for trial-by-trial acquisition data).

Of the 8 participants who met the criteria for avoidance conditioning and were subsequently tested for derived transformation (Phase 6), 6 participants (P1, P2, P3, P7, P8, and P9) produced the derived avoidance response during all presentations of C1 (see Figure 2). P4 emitted the avoidance response once (17%) during C1 trials and never during C2 trials, and therefore failed to meet the criteria for derived avoidance. P5 emitted the avoidance response four times (67%) during C1 trials and never during C2 trials. Therefore, 7 out of 8 participants met the criteria for derived transformation of avoidance response functions in accordance with Same and Opposite relational frames.

Table 3

Number of avoidance and nonavoidance responses emitted during B1 and B2 trials and the total number of trials (and means and standard deviations) during the avoidance-conditioning phase for all participants who passed the arbitrary relational test.

	Avoidance response		Nonavoidance response		
Participant	B1	B2	B1	B2	Total number of trials
P1	16	0	3	21	40
P2	19	0	2	23	44
P3	28	0	2	29	59
P4	14	0	6	22	42
P5	22	0	1	25	48
P7	33	0	1	31	65
P8	28	1	1	31	61
P9	24	1	1	25	51
P10	19	0	4	22	45
P11	19	0	5	25	49
P12	18	0	2	22	42
Mean	21.81	0.18	2.63	25.09	49.63
SD	5.82	0.40	1.68	3.67	8.48

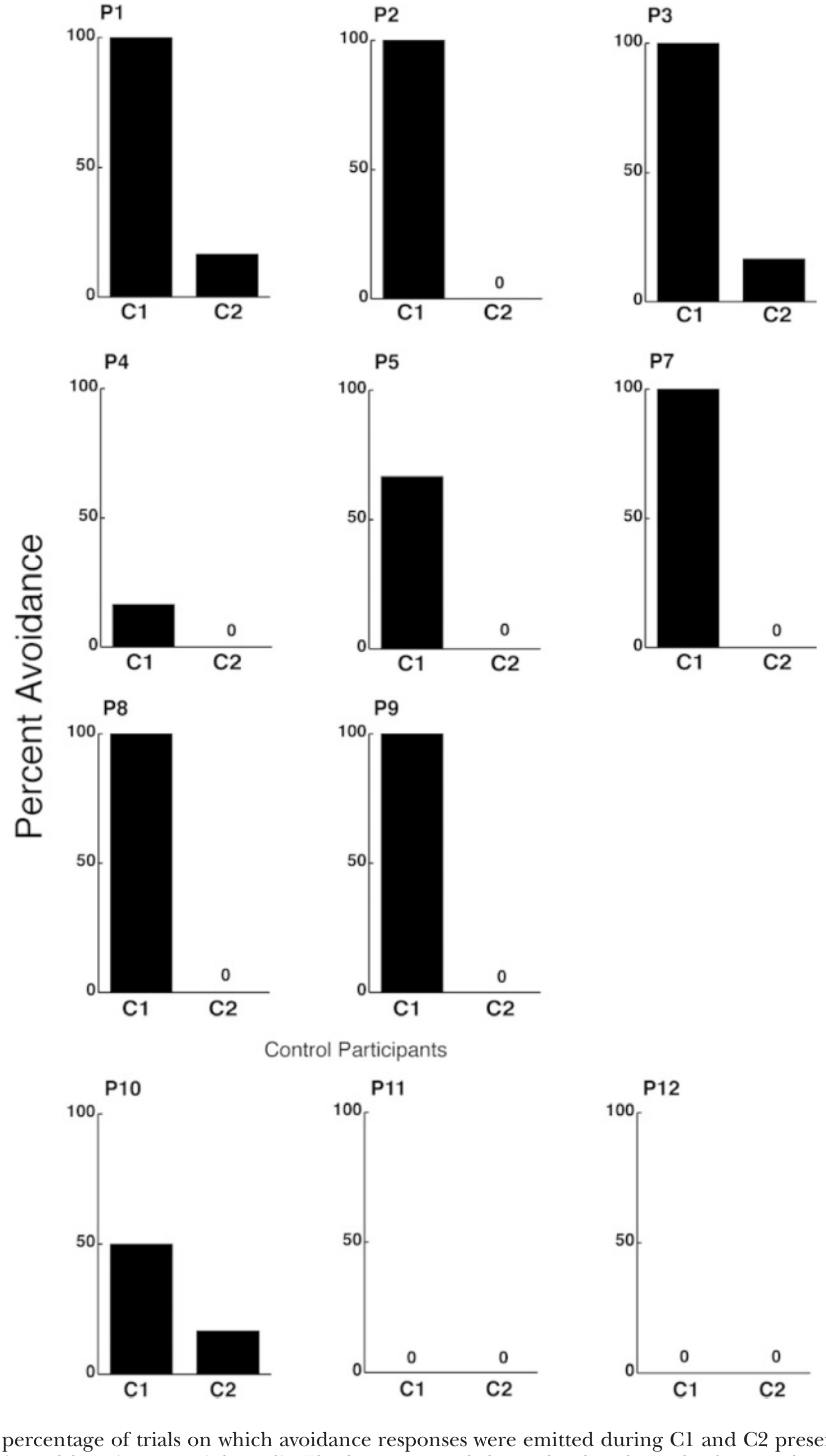

Fig. 2. The percentage of trials on which avoidance responses were emitted during C1 and C2 presentations during the transformation of functions test (Phase 6). The bottom panel shows the data from the 3 control participants (P10-P12) who were not exposed to nonarbitrary and arbitrary relational training and testing.

Control participants. Table 3 shows that P10–P12 required between 42 and 49 trials to meet the criteria for conditioned avoidance. The bottom panel of Figure 2 shows that none of the relational control participants emitted the predicted, correct performance during either the C1 or C2 probe trials. P10 emitted the avoidance response during three C1 trials and one C2 trial, while both P11 and P12 never emitted the avoidance response.

DISCUSSION

The present findings clearly demonstrate that humans may acquire avoidance responses to stimuli that signal aversive events in accordance with the relational frames of Same and Opposite. The findings from the control participants also show that consistent and correct performance on the test for transformation of functions only emerges when the relevant relational network has been trained and tested. Overall, the present findings extend those of Augustson and Dougher (1997) by demonstrating a transformation of avoidance response functions in accordance with the relational frames of Same and Opposite and by employing a new avoidance conditioning procedure with images and sounds as the aversive events.

A possible criticism of the current study is that equivalence relations rather than the relational frames of same and opposite may have produced the transformation of functions. Specifically, participants were presented with A1 on both SAME and OPPOSITE trials, and choosing B1 and C1 was reinforced in the presence of the SAME cue, and choosing B2 and C2 was reinforced in the presence of the OPPOSITE cue. It is possible that participants may have ignored the sample and formed simple equivalence relations by responding to the contextual cues as samples (i.e., SAME–B1–C1 and OPPOSITE–B2–C2). Consequently, the derived avoidance response to C1 could have emerged via these simple equivalence relations.

This outcome is, however, highly unlikely for the following reasons. First, the Same and Opposite nonarbitrary training required that participants respond to both contextual cues *and* samples. Second, to pass the arbitrary relational test, responding to both cues and samples was required. Third, the arbitrary relational test presented the B and C stimuli as both samples and comparisons, respectively. In effect, if participants were simply responding to the contextual cues as samples, on being presented with B2 as a sample and C2 as a comparison in the presence of the OPPOSITE cue, a participant should be inclined to select C2 because C2 was always correct in the presence of OPPOSITE during training. However, participants did not relate C2 to B2 in the presence of OPPOSITE, but in fact related C1 to B2 in the presence of OPPOSITE. Similarly, if the SAME cue was functioning as a sample, participants should have always selected C1 in the presence of SAME, but instead participants choose C2 in the presence of B2 (and vice versa). Indeed, while the derived relation of sameness that emerged between the B1 and C1 stimuli may be considered to be an example of an equivalence relation, the derived relation of sameness that emerged between B2 and C2 involved two trained opposite relations (both B2 and C2 are the opposite to A1 and therefore the same as each other).

In summary, to account for the transformation performances in terms of simple equivalence relations, we are forced to accept that the participants responded to the cues and samples during SAME and OPPOSITE nonarbitrary training, then during arbitrary relational training responded to the cues as samples, then during arbitrary relational testing reverted to cue/sample control, and then finally during the avoidance probes test reverted again to a performance that was based on the contextual cues functioning as samples. Although theoretically possible, this would appear to be a most improbable outcome, particularly given the consistently correct responding of the majority of participants during the arbitrary relational test (see also Dymond & Barnes, 1995, 1996; Steele & Hayes, 1991; Whelan & Barnes-Holmes, 2004).

The clarity of the present findings suggests that one advantage of adopting an operant avoidance paradigm is the unambiguous nature of operant avoidance responses. The simple ''binary'' nature of the response (i.e., participants either produced avoidance responses or did not) allowed for a clear differentiation of the functions of the stimuli during the probes in a way that physiological and self-report measures do not (cf. De Houwer, Crombez, & Baeyens, 2005). The reliable acquisition of avoidance suggests that the IAPS images and IADS sounds did function as aversive stimuli. To our knowledge, this is the first demonstration of the use of images and sounds as aversive stimuli in human operant avoidance research and, as such, contributes to the existing literature on avoidance and escape behavior (e.g., Lejuez, O'Donnell, Wirth, Zvolensky, & Eifert, 1998).

Three control participants were employed to test whether the nonarbitrary and arbitrary relational training and testing phases were in fact necessary to generate the derived performances. Consistent with previous findings (e.g., Dymond & Barnes, 1994), it was shown that the transformation of avoidance response functions occurred only if participants had received the necessary training and testing to derive the relevant relational network. As such, this relatively simple control procedure demonstrated that consistent and correct derived performance only emerges following appropriate relational training and testing and not on the basis of adventitious feedback generated by the avoidance task itself. Other control procedures are, however, possible with research of this kind (Dymond & Rehfeldt, 2000). For instance, another control might involve first exposing some participants to Phases 5 and 6 and subsequently Phases 1 to 6. If participants demonstrate the predicted performance on their second, but not their first, exposure to Phase 6 this would illustrate greater functional control over the variables responsible for derived transformation. Robust experimental designs are particularly important in derived relations research, and researchers are encouraged to incorporate novel ways of demonstrating functional relations in future studies.

The present approach offers a novel means of examining the complex verbal and evaluative dimensions that clients often report as part of their avoidance strategies. For instance, opposition relations seem critical in the derived establishment of safety and avoidance behaviors across the anxiety disorders (Barlow, 2002). Anxious clients readily learn what does or may evoke fear and anxiety, and seem to quickly derive situations, contexts, and behaviors that are safe (i.e., opposition relations). Consequently, anxious clients spend more time engaging in safe behaviors that are opposite of potentially fear evoking experiences. Such issues have been relatively understudied to date and appear to warrant further investigation. Also, investigating the relative difficulties in acquiring and maintaining derived relational responding encountered by clinical populations of persons suffering from anxiety disorders and other clinical conditions that involve avoidance behavior (e.g., addictive behaviors) may further contribute towards a modern behavior-analytic approach to clinical phenomena.

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APPENDIX

Trial-by-trial acquisition data from the avoidance conditioning phase for each participant. Shown is the stimulus presented on every trial and whether the avoidance response occurred ('Avoid') or not. Note that no data are shown for P6, who did not pass the relational training and testing phases and hence was not exposed to the avoidance-conditioning phase.

	Participant					
	P1	P2	P3	P4	P5	P7
Trial	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)
1	B1	B1	B2	B1	B1	B2
2	B1 (Avoid)	B2	B1	B2	B2	B1
3	B2	B2	B2	B2	B1 (Avoid)	B1 (Avoid)
4	B2	B1	B2	B1	B2	B2
5	B1	B1 (Avoid)	B1	B2	B2	B2
6	B1	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)
7	B2	B1 (Avoid)	B2	B2	B2	B1 (Avoid)
8	B2	B2	B2	B1	B2	B2
9	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)
10	B2	B1 (Avoid)	B2	B1	B2	B1 (Avoid)
11	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B2
12	B2	B1 (Avoid)	B1 (Avoid)	B2	B2	B1 (Avoid)
13	B2	B2	B2	B2	B2	B2
14	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B2
15	B2	B1 (Avoid)	B1 (Avoid)	B2	B2	B1 (Avoid)
16	B2	B1 (Avoid)	B2	B1	B1 (Avoid)	B2 (Avoid)
17	B1 (Avoid)	B2	B2	B2	B1 (Avoid)	B2
18	B2	B2	B1 (Avoid)	B2	B2	B1 (Avoid)
19	B2	B1 (Avoid)	B2	B1	B1 (Avoid)	B2
20	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)	B2	B1 (Avoid)
21	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)
22	B2	B2	B2	B2	B1 (Avoid)	B2
23	B2	B2	B2	B1 (Avoid)	B2	B1 (Avoid)
24	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B2	B1 (Avoid)
25	B2	B1 (Avoid)	B2	B2	B1 (Avoid)	B2
26	B1 (Avoid)	B2	B2	B1 (Avoid)	B2	B1 (Avoid)
27	B1 (Avoid)	B2	B1 (Avoid)	B2	B2	B1 (Avoid)
28	B2	B1 (Avoid)	B1 (Avoid)	B2	B1 (Avoid)	B2
29	B1 (Avoid)	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)	B2
30	B2	B2	B1 (Avoid)	B2	B2	B1 (Avoid)
31	B2	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)	B2
32	B1 (Avoid)	B2	B2	B2	B1 (Avoid)	B2
33	B2	B2	B1 (Avoid)	B1 (Avoid)	B2	B1 (Avoid)
34	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B2	B2	B1 (Avoid)
35	B1 (Avoid)	B2	B2	B2	B1 (Avoid)	B2
36	B2	B2	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)
37	B2	B1 (Avoid)	B1 (Avoid)	B2	B2	B1 (Avoid)
38	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B2	B2
39	B1 (Avoid)	B2	B2	B2	B1 (Avoid)	B1 (Avoid)
40	B2	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)
41		B1 (Avoid)	B2	B1 (Avoid)	B2	B2
42		B2	B2	B2	B1 (Avoid)	B2
43		B1 (Avoid)	B1 (Avoid)		B2	B1 (Avoid)
44		B2	B1 (Avoid)		B1 (Avoid)	B1 (Avoid)
45			B2		B2	B2
46			B2		B2	B1 (Avoid)
47			B1 (Avoid)		B1 (Avoid)	B1 (Avoid)
48			B1 (Avoid)		B2	B2
49			B2			B2
50			B1 (Avoid)			B1 (Avoid)
51			B2			B2
52			B1 (Avoid)			B2

APPENDIX

(*Continued*)

	Participant					
	P1	P2	P3	P4	P5	P7
Trial	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)
53			B1 (Avoid)			B1 (Avoid)
54			B2			B1 (Avoid)
55			B1 (Avoid)			B2
56			B2			B2
57			B1 (Avoid)			B1 (Avoid)
58			B1 (Avoid)			B1 (Avoid)
59			B2			B2
60						B2
61						B1 (Avoid)
62						B2
63						B2
64						B1 (Avoid)
65						B2

	Participant				
	P8	P9	P10	P11	P12
Trial	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)
1	B1	B2	B1	B1	B2
2	B1 (Avoid)	B1	B2	B1	B1 (Avoid)
3	B2	B1 (Avoid)	B1	B2	B2
4	B2 (Avoid)	B2	B1	B1	B1
5	B1 (Avoid)	B1 (Avoid)	B2	B1	B2
6	B1 (Avoid)	B2	B2	B2	B1
7	B2	B1 (Avoid)	B1 (Avoid)	B2	B1 (Avoid)
8	B2	B1 (Avoid)	B2	B1	B2
9	B1 (Avoid)	B2	B1 (Avoid)	B2	B1 (Avoid)
10	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B2
11	B2	B2	B2	B2	B2
12	B2	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)
13	B1 (Avoid)	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)
14	B1 (Avoid)	B2	B2	B2	B2
15	B2	B2	B1 (Avoid)	B2	B2
16	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)
17	B1 (Avoid)	B1 (Avoid)	B2	B2	B2
18	B2	B2	B1	B2	B2
19	B1 (Avoid)	B2 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)
20	B1 (Avoid)	B1 (Avoid)	B2	B2	B2
21	B2	B2	B1 (Avoid)	B2	B2
22	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)
23	B1 (Avoid)	B2	B2	B1 (Avoid)	B2
24	B2	B1 (Avoid)	B2	B2	B2
25	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)
26	B1 (Avoid)	B2	B2	B1 (Avoid)	B1 (Avoid)
27	B2	B1 (Avoid)	B1 (Avoid)	B2	B2
28	B1 (Avoid)	B1 (Avoid)	B2	B2	B2
29	B2	B2	B2	B1 (Avoid)	B1 (Avoid)
30	B2	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)
31	B1 (Avoid)	B1 (Avoid)	B2	B2	B2
32	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)
33	B2	B1 (Avoid)	B2	B2	B1 (Avoid)
34	B2	B1 (Avoid)	B1 (Avoid)	B2	B2

APPENDIX

(*Continued*)

	Participant				
	P8	P9	P10	P11	P12
Trial	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)	Event (& Avoidance Response)
35	B1 (Avoid)	B2	B2	B1 (Avoid)	B1 (Avoid)
36	B2	B1 (Avoid)	B2	B2	B1 (Avoid)
37	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)	B2
38	B1 (Avoid)	B2	B1 (Avoid)	B2	B2
39	B2	B1 (Avoid)	B2	B2	B1 (Avoid)
40	B2	B1 (Avoid)	B1 (Avoid)	B1 (Avoid)	B2
41	B1 (Avoid)	B2	B1 (Avoid)	B2	B1 (Avoid)
42	B2	B1 (Avoid)	B2	B2	B2
43	B2	B2	B2	B1 (Avoid)	
44	B1 (Avoid)	B2	B1 (Avoid)	B1 (Avoid)	
45	B2	B1 (Avoid)	B1 (Avoid)	B2	
46	B1 (Avoid)	B1 (Avoid)		B2	
47	B2	B2		B1 (Avoid)	
48	B2	B2		B1 (Avoid)	
49	B1 (Avoid)	B1 (Avoid)		B2	
50	B2	B1 (Avoid)			
51	B2	B2			
52	B1 (Avoid)				
53	B2				
54	B1 (Avoid)				
55	B2				
56	B2				
57	B1 (Avoid)				
58	B2				
59	B1 (Avoid)				
60	B1 (Avoid)				
61	B2				
62					
63					
64					
65					