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A DERIVED RELATIONS ANALYSIS OF APPROACH–AVOIDANCE CONFLICT: IMPLICATIONS FOR THE BEHAVIORAL ANALYSIS OF HUMAN ANXIETY

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The current article reports two experiments designed to examine the effects of creating competing approach and avoidance response functions for 2 stimuli that participate in the same derived stimulus relation. Experiment 1 involved establishing each of 2 distinct members (i.e., B1 and D1) of the same 1-node equivalence relation (A-B-C-D) as a discriminative stimulus for avoidance and approach responses, respectively. During a test phase, participants were presented with equivalence relation members that were of equal nodal distance from each of the discriminative stimuli (e.g., C1). Approach and avoidance responses during this probe phase were highly varied across participants but stable within participants. In general, approach and avoidance responses were observed with equal frequency during probe trials. Experiment 2 addressed several procedural artefacts, including the absence of response time data. Experiment 2 replicated the findings of Experiment 1. Elongated response latencies during probe trials in Experiment 2 support the idea that an approach–avoidance conflict was generated using the current laboratory preparation. These findings have implications for our understanding of the etiology of anxiety disorders.

Key words: avoidance, anxiety, Acceptance and Commitment Therapy, derived relational responding, transfer of functions

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In recent years, behavior analysts interested in avoidance and anxiety have devoted increasing research attention to those instances of fear and avoidance for which a clear history of respondent or operant conditioning cannot be identified (e.g., Marks, 1981, 1987; Rachman, 1991). It is now argued that crucial to developing a more sophisticated account that can accommodate instances of apparently "unconditioned" anxiety is the observation that verbally able humans have been shown to derive relations among stimuli, and that neutral stimuli can gain both eliciting and discriminative functions without direct training with little difficulty (Friman, Hayes, & Wilson, 1998; see also Dymond & Roche, 2009, for an extended review).

In particular, the derived transfer of function effect (see Dymond & Rehfeldt, 2000) has been used to explain why people display avoidance in situations where there appears to be no history of direct conditioning for such behavior (see also Barlow, 2002). Two well-cited studies together provide evidence that avoidance responses may emerge in the absence of a direct history of associative conditioning or reinforcement. The first study (Dougher, Augustson, Markham, Greenway, & Wulfert, 1994) involved first establishing two four-member equivalence relations (A1-B1-C1-D1 and A2-B2-C2-D2). A differential autonomic conditioning procedure involving electric shock as the unconditioned stimulus was then used to establish one stimulus from one derived relation (i.e., B1) as a CS+ for elicited fear. Another stimulus (i.e., B2) was established as a CS–. Elicited fear was measured in terms of skin conductance. Once conditioned fear elicitation was established for B1 and not B2, the C stimuli (indirectly related to the B stimuli) were presented during derived fear probe trials. Participants' skin conductance responses to the C1 and C2 stimuli in the absence of a US were similar to those evoked by B1 and B2 during conditioning.

In the second study, Auguston and Dougher (1997) trained 8 participants in the formation of two 4-member equivalence relations (A-B-C-D). Next, 1 member of one of the equivalence classes (B1) was established as a discriminative stimulus for avoidance. The avoidance response was demonstrated to transfer to the other members of that particular equivalence class (C1, D1) but not to members of the other equivalence class. This effect was argued by the authors to represent a possible etiology of avoidance behaviors that would seem to have emerged without any overt history of reinforcement for avoidance in the natural environment (see also Dymond & Roche, 2009; Dymond, Roche, Forsyth, Whelan, & Rhoden, 2007, 2008; Roche, Kanter, Brown, Dymond, & Fogarty, 2008). Thus, evidence exists to suggest that derived relational processes help in explaining instances of fear and avoidance behaviors for which a direct history of associative conditioning or reinforcement for avoidance appears to be absent (Hayes, 2004).

Importantly, one dimension of real-world fear and anxiety that has yet to be subjected to experimental analysis is the role of approach–avoidance conflicts in the behavioral repertoire of the anxious client. More specifically, while early research characterized phobias entirely in terms of conditioned and elicited anxiety responses coupled with reinforced escape or avoidance responses to discriminaitve stimuli (i.e., two-factor theory: Mowrer, 1947), this idea was eventually challenged, and conflicting opinions have since been raised (see Costello, 1970, 1971; Powell & Lumia, 1971; Wolpe, 1971). For instance, four decades ago Costello (1970) argued that the types of conditioned avoidance responses that have been regarded by behavior therapists as providing adequate experimental analogs of phobic behavior are dissimilar to such behaviors because (a) avoidance responses can be viewed as adequate coping behaviors, and (b) they do not involve conflict with approach behaviors, and such a conflict appears to be characteristic of clinical phobias.

Other researchers have also made the case that in clinical anxiety, approach and avoidance contingencies work in parallel and even in combination with each other (Forsyth, Eifert, & Barrios, 2006; Hayes, 1976). In other words, even the combined processes of respondently conditioned (or derived) fear elicitation and operantly conditioned (or derived) avoidance do not adequately explain many real-life cases of clinical anxiety. Rather, it may be the prevalence of competing approach and avoidance contingencies in the environment of the suffering individual that best characterizes the distress of those described as “anxious.” In such cases, the avoidance repertoire may or may not have been established following the emergence of conditioned fear elicitation. In any case, without competing approach repertoires, an avoidance repertoire is arguably a functional rather than disordered response (Hayes, 1976). These conflicts between operant contingencies are evident in the reasons clients suffering from anxiety seek treatment (e.g., “My fear of driving means I might lose my job,” or “I can’t meet with my friends because I am afraid to drive”).

The current study was designed to examine the possibility that approach–avoidance conflicts could be modelled in the laboratory using human participants. Moreover, it was designed to generate this contingency conflict in accordance with derived relational processes in order to supplement recent research into derived avoidance responding. Experiment 1 involved establishing each of two distinct members of the same one-node, four-member equivalence relation as a discriminative stimulus for approach and avoidance responses, respectively. During a test phase, participants were presented with equivalence class members that were of equal nodal distance from each of the discriminative stimuli. It was expected that response variation would be observed both within and across participants during the probe phase.

Experiment 1

Method

Participants. Ten unpaid volunteers were recruited from personal contacts. Participants’ ages ranged from 20 to 29 years, and the mean age was 26 years. All participants were male. Of the 10 volunteers, 5 passed the equivalence training and testing (i.e., Participants 5, 7, 8, 9, and 10). Only the results of these 5 participants are discussed here.

Apparatus and Stimuli. The experiment was conducted in a research laboratory in the Department of Psychology at the National University of Ireland, Maynooth and took place in a small experimental room (1.5 × 1.5 meters) containing a personal computer with a 15-in. monitor. A computer program written in Microsoft Visual Basic® 6.0 controlled all stimulus presentations. Visual stimuli were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005). These were employed as aversive and appetitive stimuli during respondent conditioning, avoidance function training, and approach function training. A total of 20 photographs—10 aversive (e.g., bodily mutilations) and 10 appetitive (e.g., sexual situations)—were selected. Stimuli were chosen to be either maximally aversive or erotic on the basis of their standardized IAPS valences and arousal ratings (see Appendix A).

Two nonsense syllable stimuli (i.e., JOM and ZID) presented in Arial font were used as discriminative stimuli for the avoidance function and approach function training, respectively. Eight further nonsense syllables, also presented in Arial font, were utilized as sample and comparison stimuli during the training and testing stages of the experiment (i.e., CUG, JOM, PAF, MEL, VEP, ZID, LEB, and KED). In the interest of clarity, these will be labeled using the alphanumerics A1, B1, C1, D1, A2, B2, C2, and D2, respectively.

General Procedure

At least 24 hours before arriving at the laboratory, all participants signed a consent form acknowledging the distasteful and sexual nature of some of the stimuli to be used during the experiment. At this point, participants also responded to a series of printed 5-point Likert scales to rate the pleasantness and unpleasantness of three sample aversive and three sample erotic images (printed 2" × 2") to be employed in the subsequent phases. Only a sample of the stimuli were rated, in order to obtain estimates of stimulus potency for each participant, while simultaneously minimizing habituation to the full stimulus sets. The ratings did not reveal any significant divergence from those expected given the standardized IAPS valence values (see Appendix B).

Upon entering the laboratory, participants were seated at a desk facing a computer screen. Following this, they were asked to put on a pair of headphones, both to exclude auditory distractions and because of the use of auditory feedback delivered by the computer during some phases. Participants were exposed individually to eight phases, as shown in Figure 1.

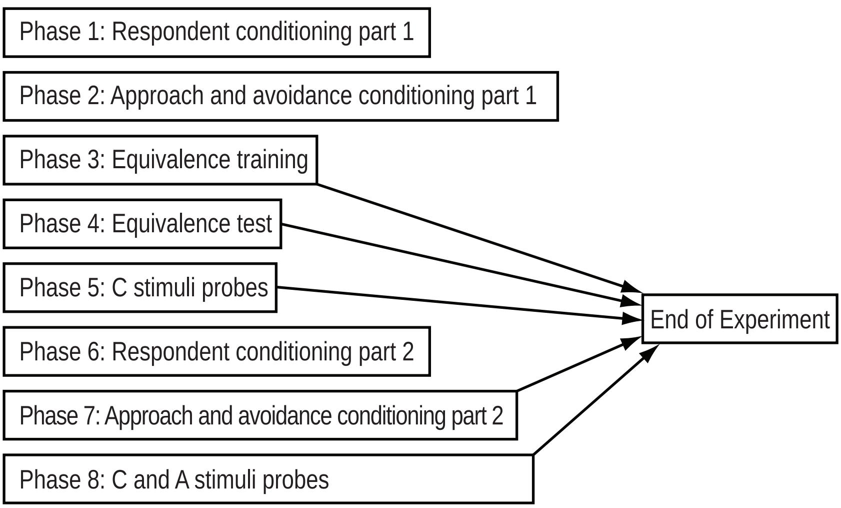

Figure 1. The procedural sequence for Experiment 1.

Phase 1: Respondent conditioning part 1. The purpose of this phase was to hasten the establishment of B1 and B2 as discriminative stimuli for avoidance and approach, respectively, in Phase 2 (operant conditioning). Before beginning this phase, standard onscreen instructions were presented that emphasized the importance of paying attention to the computer screen at all times. Participants acknowledged that they had read the instructions by clicking an onscreen button labeled "Begin."

Once the "Begin" button was clicked, the first trial of Phase 1 commenced. This stage of the experiment consisted of the presentation of either the B1 stimulus or the B2 stimulus for 3 s each on separate trials. These were immediately followed by the full-screen presentation of aversive (mutilations) or appetitive (erotic) images, respectively, for 5 s. Thus, a trace conditioning procedure was employed during this phase. Both tasks were presented once each in a block of two trials, which was in turn presented five times (i.e., 10 respondent conditioning trials). After each trial the screen went blank. Five s later, participants were asked to use the computer mouse to click on a labeled button onscreen to continue with the experiment (i.e., an observation response). This was done by presenting the phrase "Please click *Continue* to proceed with the experiment" in the center of the screen. The phrase remained onscreen until the participant clicked on the button labeled *Continue*. This response was followed immediately by the intertrial interval. To avoid temporal conditioning, the intertrial interval was varied randomly from 10 s to 30 s by the computer software.

Phase 2: Approach and avoidance conditioning, part 1. At the beginning of this phase, instructions were presented on the computer screen. These required the participant to locate the blue and yellow buttons on the computer keyboard. The instructions also advised participants that they could choose to avoid images by pressing the blue key on the keyboard before the picture was presented onscreen, and that they could view images by pressing the yellow key on the keyboard before the picture was presented. Participants acknowledged that they had read the instructions by clicking an onscreen button labeled "Begin" using the mouse button. This led to the presentation of the first trial.

During all trials, instructions appeared in blue and yellow font in the bottom left and bottom right corners of the screen, respectively, reminding the participant how to respond appropriately. The instruction in blue font on the left of the screen read, "Press the BLUE key to avoid the image," and the other, presented in yellow font on the right side of the screen, read, "Press the YELLOW key to view the image." The blue and yellow keys were on the left and right of the computer keyboard (i.e., the *A* and *L* keys, respectively) and thus spatially corresponded to the blue and yellow instructions presented onscreen. When the participant made the appropriate avoidance response (i.e., pressed the blue key in the presence of the B1 stimulus), the discriminative stimulus and instructions disappeared, the computer made a beeping noise, and the screen remained blank for 5 s.

If a participant failed to make the appropriate avoidance response, both the discriminative stimulus and the instructions remained onscreen for 3 s and were followed by an aversive image for 5 s in full-screen mode. If the participant made the appropriate approach response (i.e., pressed the yellow key in the presence of the B2 stimulus) to view an appetitive image, the discriminative stimulus and instructions disappeared, the computer made a different beeping noise, and an appetitive image was presented for 5 s in full-screen mode. If the participant failed to make an appropriate approach response, both the discriminative stimulus and the instructions remained onscreen for 3 s and were followed by a blank screen for 5 s.

Participants were again required to make an observation response 5 s after each trial by clicking the mouse. This was done by presenting the phrase "Please click *Continue* to proceed with the experiment" in the center of the screen. This sentence remained on the screen until the participant clicked on the mouse button. This response was followed by the 10-s to 30-s intertrial interval.

To enhance the resistance to extinction of the avoidance and approach responses during Phases 5 and 8, in which no images were displayed (see below), an 80% CS–US contingency was employed during Phases 2 and 7 (see also Roche et al., 2008). That is, during these phases, on 20% of trials in which the appropriate approach response was produced, a sexual image was not presented. Similarly, on 20% of trials in which an appropriate avoidance response was not produced (i.e., the participant chose to view an aversive image), an image was nevertheless not presented. If a participant produced an approach response in the presence of the B1 stimulus on an omission trial, an aversive image was not presented. Trials without images were followed by the normal mouse-click observation response and intertrial intervals as described above. However, if the participant pressed the blue key during the 3-s B1 (S^{D+}) of an omission trial, the same beeping noise associated with B1 was presented. Similarly, if the participant pressed the yellow key during the 3-s B2 (S^{D-}) of an omission trial, the beeping noise associated with B2 was presented. It is important to understand that the 80% contingency applied to the CS–US relation, and not the response–consequence relation.

Phase 2 consisted of 20 avoidance and approach conditioning trials (e.g., blocks of four trials with two presentations of both B1 and B2 in a quasirandom order, with the block of four presented five times). If participants failed to make 19 correct responses out of 20, they were reexposed to the avoidance conditioning block. This additional block was preceded by instructions, as before. Each participant was reexposed to the conditioning block up to a maximum of three times. If participants failed to make 19 correct responses out of 20 on a fourth exposure to the block of 20 trials, this signaled the end of their participation and the computer software instructed them to report to the experimenter. Participant 4 was the only individual who did not meet this criterion. If participants responded correctly to 19 trials out of 20 during any exposure to this phase, instructions for the next stage of the experiment were presented.

Phase 3: Equivalence training. Standard conditional discrimination training instructions were presented onscreen at the beginning of this phase. Participants acknowledged that they had read the instructions by clicking an onscreen button labeled "Begin." When participants clicked the onscreen "Begin" button, the first equivalence training trial was presented. During this stage a sample appeared in the top-middle of the computer screen. After 1.5 s, two comparison stimuli, one from each of the two equivalence relations, were shown, one in the bottom left and one in the bottom right of the screen. All stimuli remained on the screen until a participant clicked on one of the comparisons. After one of the comparisons had been clicked on, the screen cleared and either "Correct" or "Wrong" appeared on the screen for 1.5 s. When the feedback disappeared, the computer screen remained blank for an intertrial interval of 500 ms, after which the next trial was presented. The left and right positions of both comparison stimuli were randomized across trials.

Two four-member equivalence relations were trained during this phase (see Figure 2) in a blocked one-to-many fashion. That is, A-B relations were trained to criterion before A-C relations, which were in turn trained before A-D relations. Specifically, in the presence of A1, selection of B1 was reinforced and selection of B2 was punished. Similarly, when A2 was presented, selection of B2 was reinforced and selection of B1 was punished. The A-C and A-D relations were trained in the same way. The trained relations were A1-B1, A1-C1- A1-D1, A2-B2, A2-C2 and A2-D2.

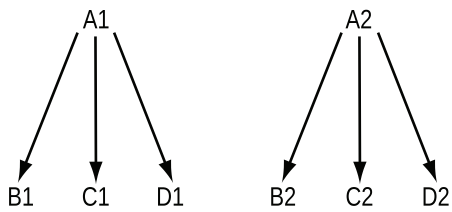

Figure 2. A schematic of the two 4-member equivalence relations and the functions established in Experiments 1 and 2.

A-B training (Phase 3a) consisted of two tasks: A1-B1 [B2] and A2-B2 [B1], where alphanumerics in square brackets indicate incorrect choices. These tasks were presented once each in a block of two in a quasirandom order, which was presented 10 times (20 trials). In effect, no one task could be presented more than two times in succession. If the participant failed to make 19 correct responses out of 20, the training block was re-administered up to a maximum of three times. If the participant failed to make 19 correct responses out of 20 on a fourth exposure to the block of 20 trials, this signaled the end of participation and the computer software instructed the participant to report to the experimenter. If the participant responded correctly to 19 trials out of 20, the next stage of the experiment was administered.

When participants passed A-B training, they were then presented with A-C training (Phase 3b). The tasks A1-C1 [C2] and A2-C2 [C1] were presented in an identical fashion. Similarly, when participants passed A-C training, they were moved on to A-D training (Phase 3c), which consisted of the tasks A1-D1 [D2] and A2-D2 [D1]. The same consistency criteria were also applied to Phases 3b and 3c. Participant 2 was the only participant not to meet the criterion for Phase 3c.

When participants had passed each of the three training blocks, a mixed training block (Phase 3d) was presented, comprising all six tasks presented five times each in a random order until the criterion of 29/30 correct responses on a single block of 30 trials was reached. If after four blocks a participant failed to make 29 correct responses in the block of 30, participation was terminated. No participants failed this phase. When participants responded correctly 29 times in a block of 30, within the four-block limit, they were then presented with instructions for Phase 4.

Phase 4: Stimulus equivalence test. The instructions presented at the outset of this phase were similar to those provided for equivalence training, with the difference that they specified that feedback would not be presented during this phase. The stimulus equivalence test probed for the formation of the derived relations: B1-D1, B2-D2, D1-B1, and D2-B2. Each task was presented once in a block of four trials in random order. The block was cycled five times. In effect, no one task was presented more than two times in succession. The blocks of 20 were presented until the participant responded correctly on 100% of the trials within a particular block (up to a maximum of four blocks).

All feedback was omitted during the equivalence testing tasks; responses were followed by the regular intertrial interval only. Participants had to respond correctly to 20 trials out of 20 to successfully complete testing. If they failed to make 20 correct responses in a block of 20, the computer automatically readministered the block. If they failed to respond correctly 20 times out of 20 trials within four consecutive testing blocks, their participation was terminated. Participants 1, 3, and 6 did not meet this criterion. When participants made 20 correct responses in a block, they were presented with the instructions for the next stage of the experiment.

Phase 5: C stimuli probes. The instruction procedure was identical to that used for Phase 2. As in Phase 2, further instructions in blue and yellow font in the bottom left and bottom right corners of the screen, respectively, were displayed while the discriminative stimuli were onscreen. The purpose of this phase was to test for derived transfer of functions from B1 and B2 to C1 and C2, respectively. This stage was similar to Phase 2, the differences being that C1 and C2 were presented in the place of B1 and B2 and no images were presented at any stage. Following all trials, regardless of the response made by participants, the screen remained blank, but the participants were still required to make an observation response 5 s after each trial. This response led to the regular intertrial interval. Each task was presented twice in a block of four in a quasirandom order. The block was presented twice (i.e., eight trials in total).

Participants were required to reach a criterion of three or more avoidance responses in the presence of the C1 stimulus (i.e., across four trials) and three or more approach responses in the presence of the C2 stimulus (i.e., across four trials). More than one approach response in the presence of the C1 stimulus or one avoidance response in the presence of the C2 stimulus resulted in a failure to pass this phase and the termination of participation in the study.

Phase 6: Respondent conditioning, part 2. This phase was identical to Phase 1 except that B1 and B2 were replaced by D2 and D1, respectively. This phase was intended to establish aversive functions for D2 and appetitive functions for D1. This particular pattern of function training juxtaposed the eliciting functions established in Phase 1, insofar as the equivalence relations would now contain members with both appetitive and aversive eliciting functions. Put simply, Phase 6 was intended to establish functional classes that were orthogonal to the equivalence relations. After 10 function training trials, the instructions for Phase 7 were displayed.

Phase 7: Approach and avoidance conditioning, Part 2. This phase was identical to Phase 2, except that B1 was replaced by D2, and B2 was replaced by D1. It complimented Phase 6 in establishing discriminative response functions for the D stimuli that would render the functional classes of appetitive stimuli (i.e., B2 and D1) and aversive stimuli (i.e., B1 and D2) orthogonal to the tested equivalence relations (i.e., in which B1 is equivalent to D1 and B2 is equivalent to D2). As with Phase 2, if participants failed to make 19 correct responses out of 20 after four exposures to the block of 20 trials, their participation was to be terminated. All participants exposed to this phase met this criterion. When the participant responded correctly to 19 trials out of 20, instructions for the next stage of the experiment were presented.

Phase 8: C and A stimuli probes. This stage was a variation of Phase 5, with the addition of A1 and A2 stimuli and the removal of the response criterion. The C1 and C2 stimuli were presented in extinction to see if there had been a change in response functions following Phase 7. The A stimuli were also presented to assess the possibility that nodal distance from the original B (discriminative) stimuli was a factor in determining the impact of Phase 7 on the functions of equivalence class members. This phase consisted of a block of four tasks (one for each of the four A and C stimuli) presented in a quasirandom order, and cycled five times (i.e., 20 trials in total).

Results and Discussion

Of the 10 participants originally recruited, 5 failed to pass one of Phases 1 through 4. That is, the dismissal of any participants occurred prior to Phase 5. Participant 4 failed Phase 2, Participant 2 failed Phase 3, and Participants 1, 3, and 6 failed Phase 4. Therefore, only the data of Participants 5, 7, 8, 9, and 10 are discussed here. All data for responses produced during Phases 2, 3, 4, and 7 are presented in Table 1. Data for Phases 5 and 8 can be seen in Table 2 and Figure 3.

Table 1
Number of Correct Responses Produced by Participants During Phases 2, 3, 4 and 7 of Experiment 1

Participant	Phase 2	Phase 3a	Phase 3b	Phase 3c	Phase 3d	Phase 4	Phase 7
5	20/20	19/20	19/20	18/20 20/20	30/30	20/20	19/20
7	20/20	19/20	19/20	19/20	30/30	20/20	19/20
8	20/2	20/20	17/20 20/20	19/20	28/30 30/30	20/20	19/20
9	15/20 19/20	20/20	20/20	20/20	30/30	20/20	19/20
10	20/20	18/20 20/20	20/20	20/20	30/30	20/20	18/20 20/20

Note: Where more than one exposure to a phase was required, correct response rates during subsequent exposures are provided on subsequent rows of the table.

Table 2
Total Number of Approach and Avoidance Responses to C stimuli During Phase 5, and to C and A Stimuli During Phase 8 of Experiment 1

	Phase 5				Phase 8							
	C1		C2		C1		C2		A1		A2	
Participant	Avoid	Approach	Avoid	Approach	Avoid	Approach	Avoid	Approach	Avoid	Approach	Avoid	Approach
5	4	0	0	3	5	0	0	5	5	0	0	5
7	3	0	0	4	0	5	5	0	0	5	5	0
8	3	0	0	4	1	4	2	3	0	5	5	0
9	3	0	0	4	0	4	5	0	0	5	5	0
10	4	0	0	4	3	1	0	5	5	0	0	5

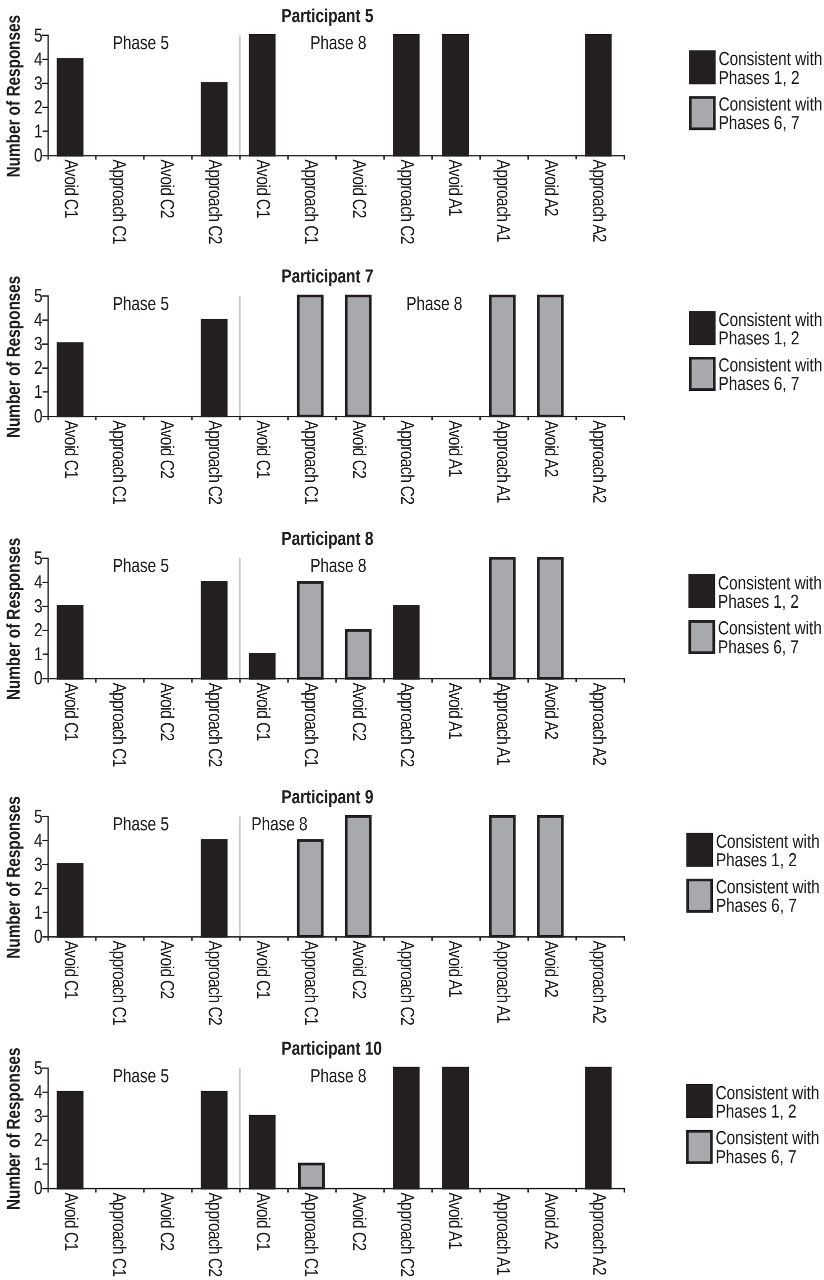

Figure 3. The distribution of each participant's responses during Phases 5 and 8 during Experiment 1. The shading of the bars indicates the conditioning phases with which the response functions were consistent.

Phase 5: C Stimuli Probes. All participants satisfied the response accuracy criterion. Participants' performances can be seen in Table 2.

Phase 8: C and A Stimuli Probes. During this test phase, participants generally responded consistently from the outset. No participant completely failed to respond during this phase. Overall, two participants responded to the C stimuli consistent with Phase 1 and 2 conditioning (i.e., participants 5 and 10) and two responded consistently with Phase 6 and 7 conditioning (i.e., participants 7 and 9). Participant 8 showed no clear pattern associated exclusively with either Phases 1 and 2 or Phases 6 and 7. Rather, his responses seem to show control by both phases simultaneously (i.e., some within-subject variability).

Responses to A1 and A2 displayed a similar pattern. Participants 5 and 10 responded consistently with Phase 1 and 2 conditioning (i.e., avoided in response to C1 and approached in response to C2), but Participants 7, 8, and 9 responded consistently with Phase 6 and 7 conditioning (i.e., avoided in response to C2 and approached in response to C1).

Despite a lack of variance in response patterns within participants, the response patterns observable at the group level would appear to be under clear stimulus control by the conflicting contingencies. That is, well-distributed patterns of responding *across* participants is precisely what we would predict when approach and avoidance contingencies are in conflict.

Experiment 2

Experiment 1 demonstrated balanced competing derived stimulus control *across* participants for both the C1 and C2 stimuli. A similar, but not identical, pattern was also observed for responses to the A stimuli. Despite the generation of competing approach and avoidance contingencies, however, responding appears to have been controlled clearly and solely by one and only one stimulus function of the A and C stimuli from the first trial of Phase 8 for four of the five participants. This may be viewed as compromising the claim that an approach–avoidance conflict was experienced by any individual participant. Experiment 2 was designed to address this potential criticism.

Following Experiment 1, it came to the experimenters' attention that feedback regarding the appropriateness of particular responses may have been inadvertently delivered during Phase 8. Specifically, during training and testing phases an expected response in the presence of a discriminative stimulus led to the immediate removal of that stimulus from the computer screen. During Phase 8, probe stimuli were removed from the screen irrespective of the response (i.e., because no particular response was either correct or incorrect). Nevertheless, the removal of stimuli immediately following responses may have functioned as a type of feedback for "correct" responding. This may explain why responses were typically consistent across probe trials, rather than varied. To remove this potential form of reinforcing feedback, Experiment 2 involved the presentation of stimuli onscreen for 3 s regardless of responses emitted during the presentation. Programmed consequences, however, were not altered.

In an effort to more sensitively measure the disruptive effect of conflicting approach and avoidance contingencies on response patterns, a response-time measure was also employed during Experiment 2. We reasoned that if extended response latencies were observed during critical probe trials compared to probes for derived transfer of functions (Phase 5), this might lend crucial support to the idea that a response conflict can be generated using the current procedures even when within-participant variability is not observed.

Two extra test phases were also added to Phase 8 in Experiment 2. Specifically, Phase 8b was designed to assess derived responses to the C stimuli following the approach–avoidance probes presented in Phase 8 (now referred to as Phase 8a). Phase 8b also involved further probes for responses to the A stimuli, followed by B stimulus probes. Phase 8b allowed the experimenters to examine more fully any changing effects of the competing approach and avoidance contingencies on the stimulus functions of the equivalence relation members across time and across repeated testing phases. A novel Phase 9 involved re-exposure to stimulus equivalence testing in an attempt to ascertain whether the probes for competing stimulus control had affected the organization of equivalence relations. Any such reorganization may help to explain the emergence of particular sources of stimulus control during critical probes.

Method

Participants. Eight male participants, aged 20 to 24 years ($M = 22$), were recruited through personal contacts. Of the 8 participants, 5 (Participants 11, 12, 13, 17, and 18) passed the equivalence training and testing and showed a derived transfer of avoidance as defined by a preset criterion. Participants 14 and 16 failed Phase 2, and Participant 15 failed Phase 3. Only the results of the 5 individuals who passed all phases are discussed here.

Apparatus and Stimuli. All apparatus and stimuli were identical to those used in Experiment 1.

General Procedure

All features of the experimental setting and general procedure were identical to those for Experiment 1. Preexperimental ratings of sample aversive and appetitive images did not reveal any significant divergence from those expected, given the standardized IAPS valence values (see Appendix C). Participants were exposed to nine phases, as shown in Figure 4.

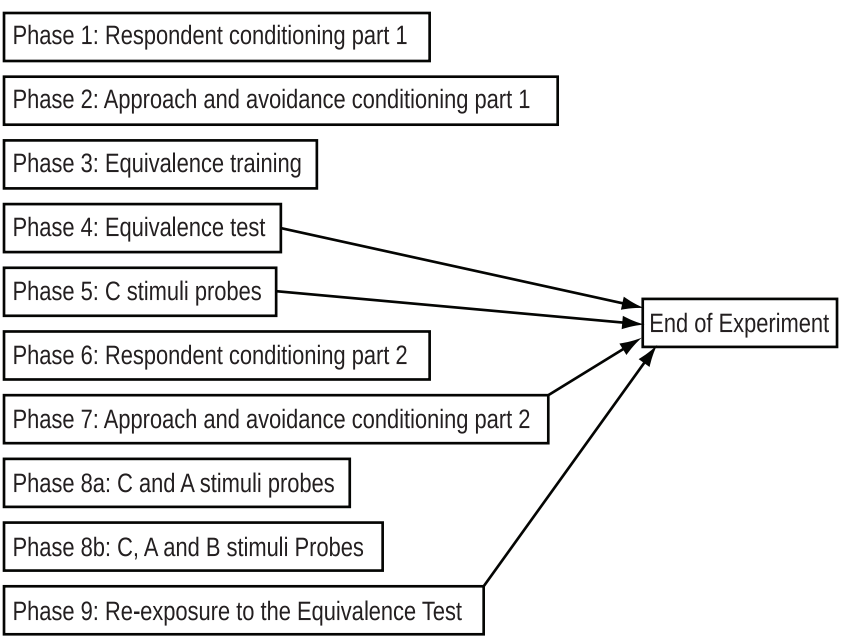

Figure 4. The procedural sequence for Experiment 2.

Phases 1 through 8a were identical to Phases 1 through 8 of Experiment 1, except for the following differences. First, during probe phases, stimuli were present onscreen for 3 s, irrespective of any responses emitted. No consequence followed a response produced before the end of the 3-s stimulus presentation until the 3 s had passed. Second, the number of probes for responses to the A and C stimuli during Phase 8a was reduced from 10 to 8.

Phase 8b. This phase consisted of probes for responses to C, A, and B stimuli and allowed for the examination of any changes in responding to C stimuli that may or may not have occurred following Phase 8a. In addition, this phase allowed for a more detailed study of any alteration in the effects of the competing approach and avoidance contingencies on the stimulus functions of the equivalence class members across time and across repeated exposure to the testing phase. During this phase, each stimulus was presented four times (24 trials) in a quasirandom order.

Phase 9. This phase comprised a re-exposure to the equivalence test in an effort to determine whether the probes for competing stimulus control had any effect on equivalence class membership. This phase was identical to Phase 4.

Results and Discussion

Of the 8 participants originally employed, 3 failed to pass one of the phases prior to Phase 4. Specifically, Participants 14 and 16 failed Phase 2 and Participant 15 failed Phase 3. Therefore, only the data of Participants 11, 12, 13, 17, and 18 are discussed here. All data for Phases 2, 3, 4, 7, and 9 are presented in Table 3. All data for responses produced during Phases 5, 8a, and 8b are presented in Tables 4 and 5, respectively.

Table 3
Number of Correct Responses Produced by Participants During Phases 2, 3, 4, 7, and 9 of Experiment 2

Participant	Phase 2	Phase 3a	Phase 3b	Phase 3c	Phase 3d	Phase 4	Phase 7	Phase 9
11	19/20	20/20	16/20 20/20	20/20	30/30	20/20	20/20	–
12	17/20 18/20 17/20 19/20	19/20	18/20 20/20	20/20	30/30	20/20	19/20	0/20
13	17/20 20/20	19/20	20/20	20/20	30/30	20/20	15/20 19/20	20/20
17	19/20	17/20 20/20	17/20 20/20	19/20	25/30 29/30	20/20	20/20	20/20
18	17/20 18/20 20/20	19/20	14/20 19/20	18/20 19/20	22/30 28/30 30/30	20/20	18/20 20/20	19/20

Note: The horizontal dash indicates that the participant was not presented with that particular phase. Where more than one exposure to a phase was required, correct response rates during subsequent exposures are provided on subsequent rows of the table.

Table 4
Total Number of Approach and Avoidance Responses to C Stimuli During Phase 5, and to C and A Stimuli During Phase 8a of Experiment 2

	Phase 5				Phase 8a							
Participant	C1		C2		C1		C2		A1		A2	
	Avoid	Approach	Avoid	Approach	Avoid	Approach	Avoid	Approach	Avoid	Approach	Avoid	Approach
11	4	0	0	4	4	0	0	4	4	0	0	4
12	3	0	0	4	4	0	0	3	4	0	0	4
13	3	0	0	4	0	4	4	0	0	4	4	0
17	3	0	0	3	0	3	4	0	0	4	3	1
18	4	0	0	3	4	0	0	4	3	1	0	4

Table 5
Total Number of Approach and Avoidance Responses to C, A, and B Stimuli During Phase 8b of Experiment 2

	Phase 8b											
Participant	C1		C2		A1		A2		B1		B2	
	Avoid	Approach	Avoid	Approach	Avoid	Approach	Avoid	Approach	Avoid	Approach	Avoid	Approach
11	–	–	–	–	–	–	–	–	–	–	–	–
12	4	0	0	4	4	0	0	4	4	0	0	3
13	4	0	0	3	4	0	0	4	3	0	0	4
17	1	3	4	0	0	4	4	0	0	4	4	0
18	2	2	0	4	3	1	0	4	4	0	0	4

Phase 5: C Stimuli Probes. As expected, all participants showed a pattern of avoiding C1 and approaching C2, although a small number of failures to respond was recorded.

Phase 8a: C and A Stimuli Probes. Participants again responded consistently with their initial responses during this phase (see Table 4). No participant completely failed to respond throughout the phase, although there were several missed responses to the C stimuli. Three participants (11, 12, and 18) responded to the C stimuli consistent with Phase 1 and 2 contingencies. Two participants (13 and 17) responded in accordance with Phase 6 and 7 contingencies. Response patterns to the A stimuli were similar and in line with responses to the C stimuli for each participant, although no missed responses were observed for A stimuli.

Phase 8b: C, A, and B Stimuli Probes. Three of the four participants exposed to this phase responded to the C and A stimuli according to the same patterns observed during Phase 8a (see Table 5 and Figure 5). However, P13 displayed an altered performance during this phase (control shifted from Phase 6 and 7 contingencies to Phase 1 and 2 contingencies). In effect, the administration of Phase 8b allowed for the observation of a degree of within-participant response variability across test blocks. Three of the four participants responded correctly to the B (conditioned) stimuli during this phase. However, P17 responded incorrectly to these stimuli by approaching B1 and avoiding B2, in line with their response pattern to the C and A stimuli. In effect, the original conditioned functions of B1 and B2 appear to have been overridden by the functions of D1 and D2 established in Phases 6 and 7 for this one participant.

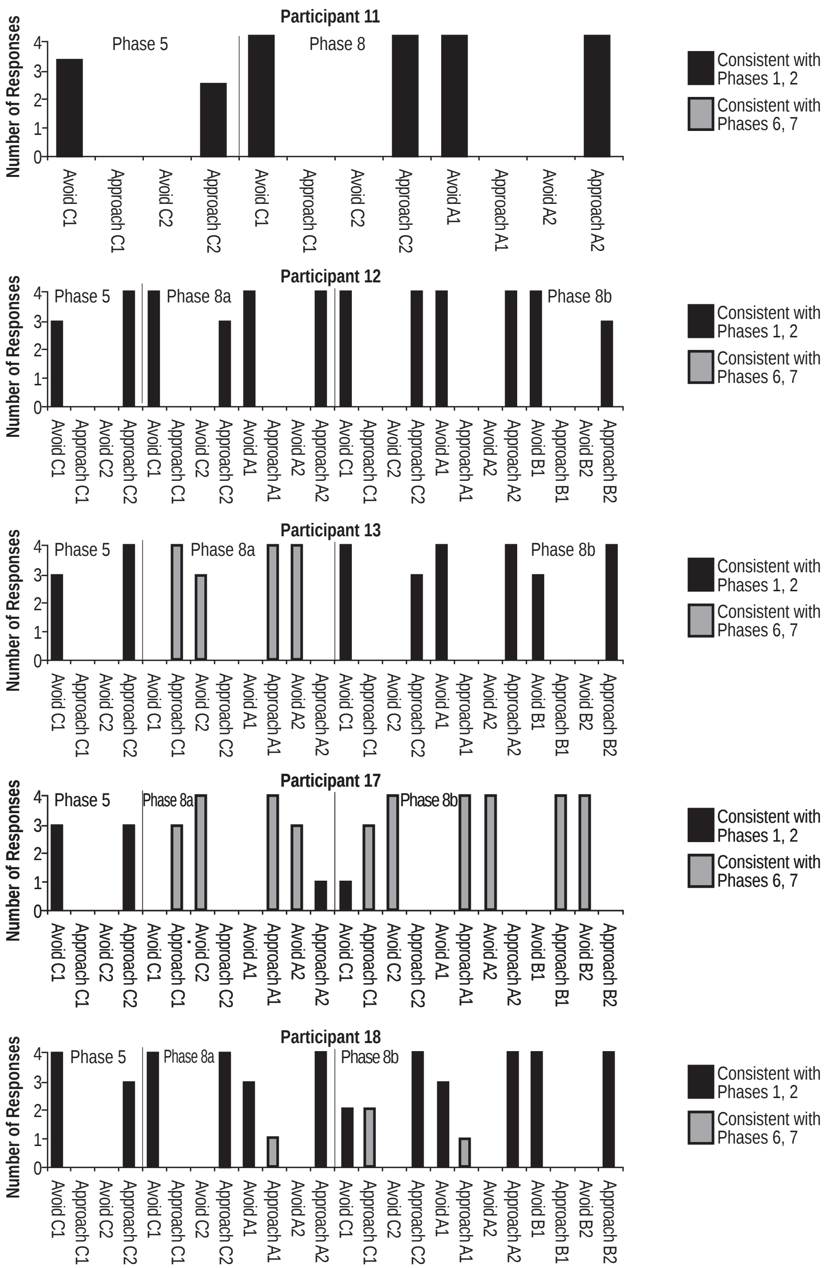

Figure 5. The distribution of each participant's responses during Phases 5, 8a and 8b during Experiment 2. The shading of the bars indicates the conditioning phases with which the response functions were consistent.

Phase 9: Re-exposure to the Equivalence Test. Due to experimenter error, Participant 11 was not exposed to this phase. Participant 12 failed the equivalence test during this phase (0/20), indicating that the emergent equivalence relations observed in Phase 3 had been completely reversed as a result of the juxtaposed functional classes established across Phases 1, 2, 6, and 7. However, Participants 13, 17, and 18 passed the equivalence test on the first and only exposure.

Response latencies. Tables 6 and 7 show the mean response times for each participant and for each probe delivered during Phases 5, 8a, and 8b, as well as the group mean response times for each probe trial. Table 6 shows that three of the five participants (P12, P17, and P18) took longer to respond to C1 during Phase 8a compared to Phase 5. Furthermore, three of the five participants (P11, P13, and P18) took longer to respond to C2 during Phase 8a compared to Phase 5. The combined mean response time to both C stimuli for all participants was higher in Phase 8a (1,595 ms) than in Phase 5 (1,462.5 ms), in line with experimental hypotheses. Response latencies to A1 and A2 during Phase 8a also tended to be consistently high compared to those observed for the C stimuli in Phase 5. Overall, the combined group mean response latency of all probes in Phase 8a was longer than the combined group mean response latency of all probes in Phase 5, indicative of a contingency conflict. Interestingly, these effects seem to be even more apparent in the second block of probing during Phase 8b (see Table 7). Indeed, all of the participants exposed to Phase 8b produced a longer mean response time to *both* the C1 and C2 stimuli than to the mean group response time to both of these stimuli during Phase 5. Moreover, the mean response time to both of the C stimuli rose from Phase 8a to 8b at the group level. The mean group response time to A1 also rose from Phase 8a to Phase 8b, while that recorded for A2 dropped slightly.

Table 6
Reaction Times (in milliseconds) to Probe Stimuli During Phases 5 and 8a

	Phase 5		Phase 8a			
Participant	C1	C2	C1	C2	A1	A2
11	1380	1137	1367	1344	1067	1633
12	1984	2078	2523	1566	1540	1496
13	1792	824	1484	1641	1156	1691
17	1766	1848	1859	1816	1777	1633
18	1000	824	1090	1258	1727	1980
Mean	1583	1342	1665	1525	1453	1687
Phase mean	1463		1582			

Table 7
Reaction Times (in milliseconds) to Probe Stimuli During Phase 8b

	Phase 8b					
Participant	C1	C2	A1	A2	B1	B2
11	–	–	–	–	–	–
12	2367	1941	1667	1680	1563	1601
13	1979	2180	1724	1475	1859	1590
17	1984	1750	1700	1563	1609	1509
18	1656	1828	1891	1906	1750	1703
Mean	1997	1925	1740	1655	1700	1622
Phase mean	1773					

As expected, the response times recorded for the original conditioned B stimuli were shortest of all.

General Discussion

The current experiments seem to have demonstrated a derived transfer of both avoidance and approach functions in accordance with four 4-member (one-node) equivalence relations. These data thereby extend the findings of Augustson and Dougher (1997), Dougher et al. (1994), Dymond et al. (2007, 2008), and Roche et al. (2008). More important, the current experiments are the first to generate an approach–avoidance conflict with human participants by virtue of the derived transfer of functions effect.

Variability in responses to the C1 and C2 stimuli was observed across, but typically not within, participants, in both Experiments 1 and 2. The observed distribution of approach and avoidance responses during probe phases is as expected when well-balanced approach and avoidance contingencies are juxtaposed (i.e., equal probability of either response function emerging for any stimulus). In other words, the current experiments seem to demonstrate derived relational stimulus control over variability in response patterns *across* participants.

Only one individual (P8, Experiment 1) failed to produce a consistent pattern of responding to the C stimuli during a critical probe phase. One further participant (P13) showed a change in response patterns to the C stimuli across the two probe phases (8a and 8b) in Experiment 2. It might be surprising that more participants did not produce varied responses to stimuli within probe blocks or completely fail to respond. Indeed, the relatively clear, consistent but varying responses observed across participants in the current experiments contrast with the effects observed using functionally analogous preparations with infrahumans. The research literature suggests that animals show response rate decreases when presented with competing approach and avoidance contingencies involving food and electric shock, respectively. For instance, in one study, Miller (1948) trained rats to run an alley in order to gain access to food in a box. The rats were then shocked while eating the food. On subsequent trials, the rats typically ran the alley to a specific point before halting just short of it. According to Miller, the approach and avoidance contingencies were equal at this point in time and space. Miller found that this point of equilibrium could be altered by varying the intensity of food deprivation or shock.

Although complete failures to respond were not observed using the current procedures, hesitation in responding (as observed in preparations involving infrahumans) was recorded during conflict probes in Experiment 2. While the effect of conflicting contingencies on response latency is not apparent for all participants in Phase 8a, it does emerge clearly at the group level (i.e., mean RTs). This is a first indicator of experimental control over the approach–avoidance phenomenon generated in the current study. In addition, these effects become even clearer both within and across participants during Phase 8b.

It is important to point out that the elongated response times observed during probes in Experiment 2 are especially significant when one bears in mind that under normal circumstances we would expect to see the reverse (i.e., reduced response latencies) due to practice effects as participants move from Phase 5 to Phase 8a and on to Phase 8b. Previous evidence provided by O'Hora, Roche, Barnes-Holmes, and Smeets (2002); Reilly, Whelan, and Barnes-Holmes (2005); and Roche, Linehan, Ward, Dymond, and Rehfeldt (2004) shows that during blocks of derived relations probes, response times drop rapidly across trials and asymptote rapidly towards a value of a few hundred milliseconds. Such a performance was certainly not observed in the current study. Indeed, given the rises in response times observed across the immediately contiguous Phases 8a and 8b, there is no evidence at all for expected practice effects, and, indeed, there is an opposite trend suggestive of a response conflict.

In an attempt to generate even clearer response conflicts with human participants, researchers would do well to consider the strength of the unconditioned stimuli employed. For instance, the images employed in the current experiments as aversive and appetitive unconditioned and consequential stimuli may simply have been too weak to generate an approach–avoidance conflict that is characterized by the absence of responses and/or erratic responding across probe trials. The use of more salient visual or other unconditioned and consequential stimuli, such as mild electric shock, may allow researchers to generate more impressive analogs of approach–avoidance conflicts in the laboratory.

Another possible suggestion for future research may be to ensure the functional equivalence of the appetitive and aversive stimuli before the commencement of conditioning phases. Indeed, in the current research, subjective ratings for these stimuli were recorded at the outset of each experiment for this very purpose (see Appendices 2 and 3). These did not reveal obvious differences in ratings of the stimuli that might explain control by approach or avoidance contingencies during critical probe phases. That is, all participants rated the aversive stimuli as less pleasant than the erotic stimuli, and so approach responses to C1 during Phases 8 and 8a, for example, cannot be explained by positive subjective ratings of the aversive stimuli. Moreover, it is important to understand that participants generally produced equal amounts of approach and avoidance responses during probe phases, but these responses were distributed differently among the stimuli. That is, some avoided C1 and approached C2, while others did the reverse. No participant avoided *both* C stimuli or approached *both* C stimuli during any phase. Thus, varied but always conditional control over responding was observed during probe phases, suggesting separate control by distinct approach and avoidance stimulus functions.

Future studies may benefit from tailoring consequential functions for individual participants to establish a more precise point of the approach–avoidance equilibrium. One way of achieving this may be to record approach and avoidance rates during a free operant phase in which access to appetitive and aversive stimuli is possible on separate trials. Alternatively, psychophysiological measures, such as electrodermal activity, might be employed to assess preexperimental stimulus potency. The use of such an assessment would initially reveal whether preexperimental differences in the functions of the aversive and appetitive images were predictive of responding during the critical probe phase. Furthermore, it would allow for the observation of any physiological arousal produced by the approach–avoidance conflict trials and allow for the comparison of anxiety levels during conflict and nonconflict trials.

The reader may be surprised with the relatively low yield of participants in both Experiments. That is, 3 of 8 and 5 of 10 research volunteers were dropped from Experiments 1 and 2, respectively, due to a failure to satisfy avoidance conditioning or stimulus equivalence training and testing criteria. Interestingly, not a single participant was dropped from the study as a result of failure to demonstrate derived avoidance. Three of those participants dropped from the study failed to satisfy Phase 2 conditioning criteria. This is most likely due to the low salience of the consequential stimuli employed (i.e., the IAPS images) for those participants. Future studies might employ a screening procedure involving a free operant phase, such as that described above, in which the potency of the consequential stimuli to be employed in Phase 2 could be established in advance. Alternatively, more salient stimuli, such as electric shocks and money, could be employed as aversive and appetitive consequential stimuli, respectively.

A further five participants failed to pass either stimulus equivalence training or testing. This constitutes one third of the participants who were exposed to these phases. Unfortunately, while these yields are disappointing, they are not unusual. In fact, several studies have examined various factors that may raise yields from stimulus equivalence training paradigms closer to 100%. For instance, some studies have compared the relative yield rates of one-to-many (A-B, A-C, A-D), many-to-one (B-A, C-A), and linear training (A-B-C-D) protocols (e.g., Arntzen & Holth, 1997; Hove, 2003; Smeets & Barnes-Holmes, 2005). Interestingly, however, the current study consciously employed quite effective procedures for training and testing purposes. That is, a blocked rather than a massed design was used to first establish each baseline conditional discrimination in isolation before all conditional discriminations were trained simultaneously. This is a method long understood to increase acquisition rates of conditional discriminations (see Doan & Cooper, 1971). In addition, a one-to-many training protocol was employed, rather than the less effective linear protocol (Arntzen & Holth, 1997).

Researchers have recently suggested that the matching to sample format (MTS) itself may not be suitable for generating 100% yields with appropriate participants. Indeed, several researchers have developed alternative novel methodologies for establishing derived relations, such as stimulus pairing (e.g., Barnes, Smeets, & Leader, 1996; Fields, Doran, & Marroquin, 2009; Fields, Reeve, Varelas, Rosen, & Belanich, 1997; Layng & Chase, 2001), a go/no-go procedure (e.g., Cullinan, Barnes-Holmes, & Smeets, 2001; Debert, Matos, & McIlvane, 2007), and simultaneous discrimination techniques (e.g., McIlvane, Kledaras, Callahan, & Dube, 2002; Smeets, Barnes-Holmes, & Cullinan, 2000). One highly novel alternative methodology is the Relational Evaluation Procedure (REP; Cullinan et al., 2001; O’Hora, Barnes-Holmes, Roche, & Smeets, 2004; Stewart, Barnes-Holmes & Roche, 2004; see also Barnes-Holmes, Hayes, Dymond, & O’Hora, 2001, for a detailed outline). The purpose of the REP is to assess participant reports on the relations between stimuli presented in pairs, rather than to control selection of the relata themselves. Responses are typically made by confirming as true or false the accuracy of a relational statement (e.g., “A is the same as B”), which can involve arbitrary stimuli with experimentally established functions or words from the vernacular. This procedure has the advantage of allowing large numbers of stimulus relations to be trained in a short space of time using an intuitive procedure that more closely parallels the format of often well-established reading repertoires. These features also apply to the recently developed extension of the REP known as the Relational Completion Procedure (RCP; Dymond et al., 2007, 2008). Using such relational training methodologies, which draw upon preexperimentally established repertoires, such as reading, may be particularly appropriate when attempting to establish derived stimulus relations with children or those with intellectual difficulties (see Cassidy, Roche, & Hayes, in press).

The relational evaluation training methods may produce more respectable yields for derived relational responding than we have been used to with MTS (see Dymond & Whelan, 2010, for empirical evidence). Researchers intending to investigate complex forms of derived relational responding and transfer of functions in future research, therefore, should consider migrating from MTS to one of these more recently developed methodologies.

The current findings may have some relevance to the literature on nodal distance in derived relational responding. Specifically, it would appear that there were more differentiated patterns of responding to the A stimuli relative to C stimuli during probe phases in both experiments. The tendency for responses to the C stimuli to be more varied than those to A stimuli may result from differences in the relational complexity involved in these two trial types. More specifically, responding to the C stimuli involved derived transitive relations (between C and D, and C and B), whereas responding to A stimuli required responding only to a symmetrical relation (i.e., between B and A). Similarly, in Experiment 2, response times to the A stimuli were generally shorter than those observed for the C stimuli (although probes using the C stimuli also measured a response conflict). As we would expect, response times to the conditioned B stimuli during Phase 8b were generally shorter than those observed for the symmetrically related A stimuli and the transitively related C stimuli. This observation is fully in line with previous research showing that responding at the level of transitive relations is a more complex task than responding at the level of symmetrical relations and is associated with longer response latencies (e.g., O'Hora et al., 2002; see also Reilly et al., 2005).

At this point, we should address what might be learned from the current findings about the relationship between functional and stimulus equivalence. Consideration of this issue may also provide some insights into performances during probe phases. Specifically, the current experimental preparations bear some functional similarity to preparations used to examine the effect of established functional classes on the emergence or reorganization of stimulus equivalence classes, and vice versa (e.g., Roche, Barnes, & Smeets, 1997; Tyndall, Roche, & James, 2004, Wirth & Chase, 2002). Such studies have generally found that incongruous relations between functional and stimulus equivalence classes lead to the delayed emergence or disruption of one or the other. Thus, we might expect the competing functional classes established in the current experiments to lead to either equivalence relation disruption or a failure for functional relations (i.e., B1–D2 and B2–D1) to emerge in the first instance. More specifically, when D1 acquired its appetitive functions in Phases 6 and 7, it may have caused the reversal of the previously derived aversive C1 functions and conditioned B1 functions, due to the preexistence of a derived B1–C1–D1 equivalence relation. Similarly, when D2 acquired its aversive functions in Phases 6 and 7, it may have led to the reversal of the previously derived appetitive C2 functions and the conditioned B2 functions. If this were to occur, we would expect to observe only one derived function for the C1 and C2 stimuli (i.e., no approach–avoidance competition) during critical probe phases. Given that the functions of D1 and D2 in Phases 6 and 7 were appetitive and aversive, respectively, we might expect to see approach responses to C1 and avoidance responses to C2 for some participants during the conflict probe trials. Indeed, there is research evidence for this precise outcome. Specifically, Wirth and Chase (2002) found that the reversal of selected baseline simple discriminations used to disrupt two functional equivalence classes resulted in the complete reversal of response functions across both classes. They argued that this is to be expected because once functional equivalence among stimuli is established, any change in responding applied to one stimulus of a set must, by definition, be applied similarly to the other stimuli in the class.

Of course, a pattern of responding consistent with the foregoing account (i.e., approach C1 and avoid C2) was not observed for all participants in the current study. Moreover, only one participant from Experiment 2 (P17) showed a reversal of the conditioned B1 and B2 functions. Thus, an account in terms of disrupted stimulus functions by incongruous stimulus equivalence relations is, if tenable, at least insufficient to account for all of the current data. The performance of P13 should also be taken into account in any serious consideration of the foregoing explanation. This participant demonstrated control by Phase 6 and 7 contingencies during Phase 8a (i.e., approached C1 and avoided C2) but *did not* show reversal of the conditioned B stimulus functions in Phase 8b. Moreover, the source of control over responses to C and A stimuli shifted from Phase 8a to 8b, in the absence of any further intervention. What the current data show, in summary, therefore, is possible evidence of disruption by stimulus equivalence relations of conditioned stimulus functions for one participant (P17) and possible disruption of stimulus equivalence classes by incongruous functional relations for another participant (P12). Clearly, this issue is a complex one, and the possibility of changes in stimulus functions and class structure across phases cannot be dismissed. However, from the varying cases described above, it would appear that an account of the current data in terms of class disruption would have to modify the explanatory process to take account of each individual participant performance. This is clearly less parsimonious than the competing contingencies account offered here.

Finally, the conflict experienced by participants in the current research was likely different from that experienced by anxious clients in the world outside the laboratory. More specifically, anxious clients may sometimes find themselves in stimulating contexts in which a failure to respond appropriately and rapidly produces an enormously punishing consequence (e.g., a panic attack may be caused by difficulty in discriminating a threatening stranger from a benign friend). In such a context, physiological signs of distress and disruption to normal response rates would likely be observed. In contrast, the consequences of “incorrect” responses during the current probe phases were relatively minor. Future studies should focus attention on generating more robust approach and avoidance responses by using more salient stimuli. Motivational variables might also be manipulated through the use of establishing operations relevant to the stimuli employed. These potential improvements notwithstanding, the current research extends the available literature on derived avoidance by showing that, in principle, both approach and avoidance functions can be derived simultaneously by human participants. Such conflicts result in delayed responding for most participants and response pattern variability across participants. The current experimental paradigm, therefore, may serve as a model for understanding forms of human anxiety.

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Appendix A

Mean and Standard Deviation Valence and Arousal Ratings for the IAPS Stimuli Employed

Stimulus number and name	Valence		Arousal	
	M	*SD*	*M*	*SD*
IAPS picture # 3010 Mutilation	1.71	1.19	7.16	2.24
IAPS picture # 3030 Mutilation	1.91	1.56	6.76	2.10
IAPS picture # 3053 Burn Victim	1.31	0.97	6.91	2.57
IAPS picture # 3060 Mutilation	1.79	1.56	7.12	2.09
IAPS picture # 3068 Mutilation	1.80	1.56	6.77	2.62
IAPS picture # 3069 Mutilation	1.70	1.41	7.03	2.41
IAPS picture # 3130 Mutilation	1.58	1.24	6.97	2.07
IAPS picture # 3250 OpenChest	3.78	1.72	6.29	1.63
IAPS picture # 3063 Mutilation	1.49	0.96	6.35	2.60
IAPS picture # 3000 Mutilation	1.59	1.35	7.34	2.27
IAPS picture # 3062 Mutilation	1.87	1.31	5.78	2.57
IAPS picture # 3080 Mutilation	1.48	0.95	7.22	1.97
IAPS picture # 4800 EroticCouple	6.44	2.22	7.07	1.78
IAPS picture # 4810 EroticCouple	6.56	2.09	6.66	2.14
IAPS picture # 4689 EroticCouple	6.90	1.55	6.21	1.74
IAPS picture # 4683 EroticCouple	6.17	2.07	6.62	1.79
IAPS picture # 4681 EroticCouple	6.69	1.82	6.68	1.70
IAPS picture # 4680 EroticCouple	7.25	1.83	6.02	2.27
IAPS picture # 4677 EroticCouple	6.58	1.65	6.19	2.08
IAPS picture # 4651 EroticCouple	6.32	2.18	6.34	2.05
IAPS picture # 4652 EroticCouple	6.79	2.02	6.62	2.04
IAPS picture # 4656 EroticCouple	6.73	1.94	6.41	2.19
IAPS picture # 4658 EroticCouple	6.62	1.89	6.47	2.14
IAPS picture # 4659 EroticCouple	6.87	1.99	6.93	2.07

Note. IAPS ratings are standardized along a 9-point scale from low valence (i.e., pleasantness) and arousal to high valence and arousal (see Lang et al., 2005).

Appendix B

Participants' Ratings of Sample Images on a 5-point Likert Scale Taken Before Experiment 1

Participant	Aversive IAPS # 3010	Aversive IAPS # 3060	Aversive IAPS # 3069	Appetitive IAPS # 4800	Appetitive IAPS # 4689	Appetitive IAPS # 4677	Aversive Mean	Appetitive Mean
5	1	1	1	4	4	5	1	4.33
7	1	1	1	4	4	4	1	4
8	1	1	1	4	4	4	1	4
9	2	2	1	5	4	4	1.67	4.33
10	2	2	2	5	5	5	2	5

Note. The corresponding IAPS (Lang et al., 2005) catalogue number is provided for each image rated.

Appendix C

Participants' Ratings of Sample Images on a 5-point Likert Scale Taken Before Experiment 2

Participant	Aversive IAPS # 3010	Aversive IAPS # 3060	Aversive IAPS # 3069	Appetitive IAPS # 4800	Appetitive IAPS # 4689	Appetitive IAPS # 4677	Aversive Mean	Appetitive Mean
11	1	1	1	4	4	4	1	4
12	1	1	1	3	3	3	1	3
13	3	3	2	5	4	4	2.67	4.33
17	2	1	2	4	3	3	1.67	3.33
18	1	2	1	4	4	4	1.33	4

Note. The corresponding IAPS (Lang et al., 2005) catalogue number is provided for each image rated.