An Examination of Facilitated Acquisition and Transformation of Function in Derived Relational Responding

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Abstract

Studies of derived relational responding and stimulus equivalence that examine the acquisition of arbitrary stimuli into existing classes suggest that classes that are more emotionally salient facilitate the acquisition of novel members. This study examined the hypothesis that personal distress would create facilitated acquisition in deriving relations between two arbitrary stimuli and one personally distressing stimulus. Transformation of function was also measured via self-report. No facilitated acquisition effect appeared, but transformation of function was more pronounced in the distressed group. These findings suggest that transformation of function is possible before the relations are fully derived and facilitated acquisition only occurs in particular behavioral contexts.
Keywords: derived relational responding, facilitated acquisition, transformation of function, distress, stimulus equivalence

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Stimulus events often organize behavior in the absence of a direct learning history with that particular event. Many studies have examined indirect learning such as derived relational responding in matching-to-sample procedures and determined that the process of relating develops at approximately the same time as language (Devany, Hayes, & Nelson, 1986; Lipkins, Hayes, & Hayes, 1993). Because of this relationship with language in combination with the success of stimulus equivalence in the teaching of reading and language, it has been posited as one of the basic elements of human language and cognition (Hayes, Barnes-Holmes, & Roche, 2001). Thus, researchers have begun to examine the effects of including words and stimuli with pre-established functions, based on assumed contact with the social verbal community, into equivalence procedures. It was quickly determined that these stimuli impact the formation of equivalence classes. This seems to happen in three ways: (a) inhibition of formation, (b) rigid inflexibility of classes, and (c) facilitated acquisition.

Inhibition of Class Formation. Stimuli that evoke certain emotional responses are associated with inhibition of class formation, when training that should produce classes of all meaningful stimuli is given. For example, Plaud (1995) found that the formation of snake classes was inhibited in individuals with a snake phobia, but the formation of flower classes was not. More specifically, conditional discriminations were trained that produced equivalence classes among all snake words (Cobra-Rattlers-Python) or all flower words (Yucca-Daffodil-Crocus). Fear relevant stimuli produced inhibition of equivalence responding in anxious individuals; however, non-anxious individuals were not inhibited in equivalence responding for either snake or flower class. Inhibition was also noted when equivalence training procedures were intended to create classes between sexually explicit stimuli (Plaud, Gaither, Franklin, Weller, & Barth, 1998). Both these studies examined the ability of individuals to form equivalence classes in which all stimuli had similar functions. Inhibition was noted when all the stimuli in the class had stimulus functions that evoked emotional responses (sexually explicit stimuli and snakes for snake phobics).

Rigid Inflexibility of Classes. Experimental procedures designed to produce equivalence classes containing one member from two different pre-experimental equivalence classes show an inability of these classes to merge, demonstrating the inflexibility of classes of stimuli that evoke pre-experimental emotional responses. This is the counterpart of the insensitivity seen in rule-governed behavior (Matthews, Shimoff, Catania, & Sagvolden, 1977). For example, Watt, Keenan, Barnes, and Cairns (1991) trained equivalence relations between Northern Irish Catholic names, nonsense syllables, and Northern Irish Protestant symbols to individuals with either a Protestant or Catholic upbringing from either Ireland or England. Participants from Northern Ireland, where conflict between the Catholics and Protestants is ongoing, were unable to form equivalence classes including both a Protestant symbol and a Catholic name, but the English participants readily formed these classes. The authors suggest that the prior social learning of the participants interfered with the ability of individuals to form these equivalence relations.

Leslie, Tierney, Robinson, Keenan, Watt, and Barnes (1993) tested the effects of pairing threatening situations, nonsense syllables, and pleasant state adjectives in a MTS procedure in anxious and non-anxious adults. All non-anxious participants formed equivalence classes that included one stimulus from each set; however, the anxious individuals did not form equivalence classes given the same amount of training. The authors attributed this difference to previously established behavioral relations interfering with the emergence of equivalence relations in the laboratory.

Moxon, Keenan, and Hine (1993) trained relations between three traditionally male occupations and nonsense syllables and between nonsense syllables and three female names. During testing for equivalence class formation, a novel stimulus, a female occupation, was included among the male occupation stimuli. This disrupted responding for both males and females, but to a greater extent for the male participants. This was attributed to the fact that males exhibit a higher incidence of gender-role stereotyping than do females. Barnes, Lawlor, Smeets, and Roche (1996) examined the differences between responding on tests of equivalence in MTS procedures designed to train relations between the participant's own name and the word 'able' in mildly mentally handicapped children and normally developing children.

Barnes et al. determined that the mildly mentally handicapped children were more likely to chose their own name in the presence of the word 'slow' even though they had been trained that both their own name (A1) and the word 'able' (C1) went with a nonsense syllable (B1) and that both 'Val Jones' (A2) and 'slow' (C2) went with a different nonsense syllable (B2). This finding was attributed to social learning history rather than an inability to form equivalence relations, as all participants were required to pass a preliminary task in which arbitrary stimuli were used in order to be included in the analysis.

Merwin and Wilson (2005) extended the results of Barnes et al. (1996) by examining equivalence responding in normally functioning college students reporting either high or low self-esteem and distress. Merwin and Wilson determined that participants who reported low esteem and high distress were less likely to form equivalence classes that included both a self-referring (me, myself, I) stimulus and the words 'worthy, complete, competent' whereas participants with high esteem and low distress were more

likely to form these relations but less likely to form relations between 'me, myself, I' and 'deficient, broken, undesirable.'

The above studies focused on the effects of class formation including stimuli that the participant had a pre-experimental history that supported responding in opposition to the experimentally trained classes. These studies each demonstrated participants' inability to form classes containing opposing stimuli. Peoples, Teirney, Bracken, and McKay (1998) experimentally demonstrated this difficulty to merge stimuli with opposing meanings into equivalence classes. All twelve participants in the Peoples et al. (1998) study had difficulty forming equivalence relations between one stimulus that had been classically conditioned to have a "bad" meaning and one that had been classically conditioned to have a "good" meaning.

In sum, most studies of equivalence or derived relational responding examining the inclusion of meaningful stimuli that are relevant to the history of the participant have included stimuli assumed to be oppositional and part of pre-experimentally established equivalence classes (Barnes et al., 1996; Leslie et al., 1993; Merwin & Wilson, 2005; Moxon et al., 1993; Watt et al., 1991). The results of these studies show an inability of meaningful, relevant stimuli to merge two classes of pre-experimentally important classes. This inhibition has been suggested as an important factor in clinical and social problems such as anxiety (Leslie et al., 1993), social discrimination (Watt et al., 1991), gender role stereotyping (Moxon et al., 1993), self-esteem (Barnes et al., 1996), and distress (Merwin & Wilson, 2005). Given this rigidity and relevance to clinical and social problems, it is important to examine how this type of class forms. Preliminary research into the formation of these robust classes has suggested facilitated acquisition of *novel* members into classes with emotionally salient stimuli.

Facilitated Acquisition. Wilson (1998) trained participants in three conditional discriminations (A-B, A-C, A-D) in which A, C, and D stimuli were arbitrary stimuli (nonsense shapes) and B stimuli were words representing substance use (B1; i.e., alcohol, beer, whisky, wine), nature (B2; i.e., sparrow, leaf, forest, grass), or illness (B3; i.e., cancer, scar, mucus, scalpel). Participants were then tested on the derived relations (B-C, C-B, C-D, D-C, B-D, D-B). Results showed that substance abusers formed equivalence classes more readily if a drug relevant stimulus was included versus other words. In other words, the inclusion of a drug relevant stimulus facilitated the acquisition of new arbitrary stimuli into equivalence classes for substance abusers. These findings were replicated in a college population using academic distress relevant stimuli (Adcock et al., in press). Results showed that students with lower grade point averages (GPA) formed classes with the academic distress relevant stimuli that were much more robust than either arbitrary class and that individuals with lower GPA reported significantly more distress than those with higher GPAs.

Transformation of Stimulus Functions

A plausible explanation for facilitated acquisition is the transformation of stimulus functions throughout equivalence classes. A stimulus function is the effect that a stimulus has on behavior of an organism or describes the relationship between the stimulus and behavior. Research on transformation of stimulus functions has demonstrated that classically conditioned functions (i.e. shock) can transfer through relations to evoke responding to stimuli never directly paired with the unconditioned stimulus

(Dougher, Augustson, Markham, Greenway, and Wulfert, 1994) as well as that sexual excitation (Roche & Barnes, 1997), preference for soft drinks (Barnes-Holmes, Keane, Barnes-Holmes, & Smeets, 2000; Smeets & Barnes-Holmes, 2003), and mood states (Barnes-Holmes, Barnes-Holmes, Smeets, & Luciano, 2004) transfer or transform throughout equivalence classes or derived relations.

The Current Project

Research clearly shows that stimuli indirectly related to aversive events can take on the functions of that event. By extension these indirectly related stimuli can develop control over behavior. As such, it becomes important to know how these classes of stimuli form and if existing properties of the stimuli impact future equivalence class formation. To examine this issue, participants were given a MTS procedure that trained conditional discriminations (A-B and A-C), and then tested for the derivation of equivalence relations (B-C and C-B). 'A' stimuli were arbitrary shapes. 'B' stimuli were words (B1 = personally relevant negative content words, B2 = general negative words, B3 = neutral words). 'C' stimuli were nonsense syllables. Given this preparation, the current study aimed to test three hypotheses. First, it was hypothesized that classes containing stimuli that are personally relevant to the participant (B1) would acquire new members more readily than classes containing general negative or neutral stimuli. Second, it was hypothesized that participants with high levels of distress would show more facilitated acquisition (i.e., higher accuracy) in the personally relevant class than the other classes and more than the participants with lower levels of distress. Finally, it was hypothesized that arbitrary stimuli related to the personally relevant content words would show greater transformation of stimulus function than general negative words or neutral words.

Method

Participants

Three hundred sixty one participants were recruited from undergraduate courses at an urban university in the Midwestern United States. Each student received course credit for participation. The mean age of the sample was 20.90 (SD = 4.93). Seventy-six percent of the sample were female (n=275), 22.40% were male (n=81), 83.90% were Caucasian (n=303), 7.20% were Asian or Pacific Islander (n=26), 5.30% were African American (n=19), and 1.90% were Hispanic or Latino (n=7). Ninety-five percent of the samples were single (n=343), 3.00% were married (n=11), 1.70% were divorced (n=6), and 0.30% were widowed (n=1).

Materials

Demographics Questionnaire. The demographics questionnaire consisted of questions assessing age, race, and socioeconomic status.

Outcome Questionnaire. The OQ-45 is a 45-item questionnaire that measures symptoms of anxiety and depression, interpersonal functioning, and social roles with higher scores indicating higher levels of distress (Lambert, Hansen, Umpress, Lunnen, Okiishu, & Burlingame, 1997). Items are answered on a 5-point likert scale from "never" to "almost always." It results in three subscale scores and

an overall distress score. The clinical cut-off score for the OQ-45 is 63. The overall score was used in this study as the screening measure (see Screening section below).

Test for Stimulus Functions. Before and after the MTS procedure, participants were asked to complete a paper-and-pencil test for stimulus function. This 36 item form asks the participant to rate (on a five-point likert scale) each stimulus presented in the MTS procedure on 4 different domains: (a) pleasantness, (b) meaningfulness, (c) familiarity, and (d) emotionality from "very" (1) to "none" (5). The measure results in twelve scores, one for each domain for each of the three equivalence classes (PERSONAL, NEGATIVE, NEUTRAL). For ease of interpretation, each item was reverse scored so that higher scores represented a stronger stimulus function. This measure was given before and after the experimental procedure to determine if transformation of function has occurred during the experimental procedure.

Positive And Negative Affect Scales (PANAS). The PANAS is a 20-item self-report measure of positive and negative affect (Watson, Clark, & Tellegen, 1988). It measures the range of positive affect from enthusiasm and activation to sluggishness and lethargy and the range of negative affect from subjective distress and aversive arousal to calmness and serenity. Items are answered on a 5-point likert scale from "very slightly or not at all" to "extremely." It results in two scores, one score for each: positive and negative affect. Both positive and negative affect scores were examined in this study. The PANAS was given before and after the interview (described below) to detect changes in mood attributable to the interview.

Procedures

This project was reviewed and approved by the Institutional Review Board at the University of Wisconsin-Milwaukee. All participants were exposed to the elements of the experiment in the same order: screening, interview, experimental task, and debriefing.

Screening. All participants completed a packet including the Demographics Questionnaire and OQ-45. Three hundred fourteen students completed the OQ-45 (M = 50.98; SD = 19.96). Participants determined to be experiencing either high (top 25%) or low (bottom 25%) distress as measured by the OQ-45 were contacted for further participation in this study. High (HD) and Low (LD) Distress Groups were created using cut-off scores based on data reported from a Midwestern sample (M = 45.63; SD = 23.21; Lambert, et al., 1997). The HD Group was required to score above 58, and the LD Group was required to score below 33.

Sixty participants met the screening criteria and were brought into the laboratory to complete the second portion of the study. Thirty were in the HD Group (OQ-45, M = 78.30, SD = 17.43) and 30 in the LD Group (OQ-45, M = 25.13, SD = 6.79). The mean of the HD Group was 15 points above the clinical cut-off score, thus this group was highly distressed.

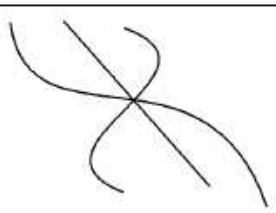
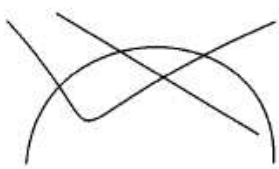
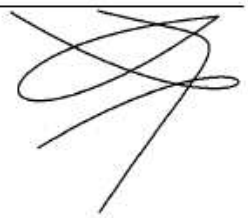
T-tests or Chi-square analyses were conducted to test the between group differences on each of the demographic variables. The mean age of the HD Group was 21.67, slightly higher than the LD Group at 19.70, but this difference was not significant, t (58) = -1.843, p = .070. Gender was similar HD and LD

Group, χ^2 (1, N = 60) = .373, p = .542, as was the ethnic makeup, χ^2 (4, N = 59) = 2.184, p = .702, and marital status, χ^2 (1, N = 60) = 3.158, p = .076. The difference in reported income was significantly different, χ^2 (4, N = 60) = 9.828, p = .020, but the median response for both groups was the less than $20,000, and both groups reported equally that someone other than themselves provided over half their income, χ^2 (1, N = 60) = .271, p = .602. The HD Group had significantly more reports of mental health care than the LD Group, χ^2 (1, N = 60) = 13.017, p = .000, but may be expected given the cut off scores used to form the HD Group.

Interview. An experimenter blind to group status interviewed each of the 60 participants to identify particular stressors. Each participant was interviewed in the same manner: the experimenter (a) described the importance of the study, (b) explained that all people experience things in their lives that are distressing/upsetting and experience anxiety and/or depression, and (c) asked them about particular things with which they were presently struggling. The events, thoughts, and feelings with which the participant reported struggling were each summarized into a single word or phrase, the accuracy of which was confirmed with the participant to be used in the MTS task. Following the interview, the participant again

Table 1.

Stimuli used in this study.

	Equivalence Class		
	Personal (1)	Negative (2)	Neutral (3)
A			
B	Words agreed upon with the participant during the interview	Angry Sad Nervous	Red Green Yellow
C	RIH	CUG	FOB

completed the PANAS (at this moment version) to determine if the interview caused a change in mood and affect.

Stimuli. Nine stimuli were used in the study (Table 1). All stimuli were contained in a 175 mm X 175 mm box presented on the computer screen. Both the A and C stimuli were arbitrary stimuli with which it was highly unlikely that the participants had any pre-experimental history. The A stimuli were nonsensical shapes that were created by the author. The C stimuli were nonsense syllables generated by a nonsense syllable-generating program created in Microsoft Visual Basic 6 by Dermot Barnes-Holmes. These stimuli should not have evoked any emotional response from the participant, and it was determined using the Test for Stimulus Functions that they did not. Table 2 shows the median responses from the Pre-Experimental Test for Stimulus Functions. The B stimuli were words with which the participants were familiar. B1 was the set of words agreed upon with the participant during the interview process and will be identified as PERSONAL in the remainder of this paper. B2 was a set of standard negative emotion words and will be called NEGATIVE for the remainder of the paper. B3 was a set of color words and will be called NEUTRAL for the remainder of the paper. Care was taken to insure that none of the words from the PERSONAL and NEUTRAL stimuli overlapped. However, on occasion participants did confirm that one of the words included on NEGATIVE was to be included on PERSONAL, and this word was removed from NEGATIVE and replaced with one of the following general negative emotion words: anxious, angry, sad, afraid, frustrated, nervous, depressed, lonely, unhappy, guilty.

Experimental Task. Participants completed a computerized MTS procedure that trained two conditional discriminations (A-B and A-C) using verbal feedback ("Well Done!") as the reinforcer presented on a FR1 schedule and tested for the derivation of equivalence relations (B-C and C-B). All instructions, conditional discrimination training, and equivalence testing was presented on a PC computer using Microsoft VisualBasic.Net programming.

All participants completed three practice trials before beginning the conditional discrimination training. Practice trials were used to familiarize participants with the MTS task. They were preceded by these instructions:

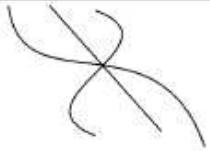
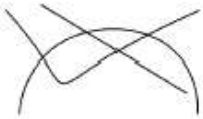
HELLO. Thank you for taking part in this experiment. Your instructions are very simple. One box will be displayed at the top of the screen and three along the bottom. You must choose one of the three along the bottom. Click on the PRACTICE button below for a few examples.

The practice trials used nonsense syllables as stimuli. Figure 1 provides a graphical depiction of what participants saw on the computer screen during the experiment. Upon completion of the three practice trials, the following appeared on the screen:

WELL DONE! During some trials you will receive feedback. During others you will not. These tasks might be confusing at times. Just do the best you can. Try to make the correct choices throughout the experiment whether you are being told you are choosing correctly or not. Work through the trials as quickly as you can. To begin click on the BEGIN EXPERIMENT button below.

Table 2.

Pre-Experimental Test for Stimulus Functions Data

	Pleasant	Meaningful	Familiar	Emotional
	A little	Neutral	Neutral	Neutral
	Neutral	Not	Un-familiar	Neutral
	Un-pleasant	Not	Un-familiar	Neutral
CUG	Neutral	Not	Un-familiar	Neutral
RIH	Neutral	Not	Un-familiar	Non-emotional
JOZ	Neutral	Not	Un-familiar	Neutral/ Non-emotional

During Phase 1 participants were trained to pick stimulus B1 from an array containing all B stimuli, given A1 as a sample, B2 given A2, and B3 given A3. There were nine trials in each trial block; each stimulus was presented as the sample three times during each trial block. Trials were presented in random order. Participants were required to correctly match all three 'A' sample stimuli to their assigned 'B' comparison stimuli (A1-B1, A2-B2, A3-B3) before moving on to the next training phase. Upon reaching the criterion responding level (100% or 9 correct responses out of 9 trials) in Phase 1, the

participant moved on to Phase 2, which trained ‘A’ to ‘C’ conditional discriminations. Phase 2 was identical to Phase 1, except that ‘C’ stimuli were used as comparison stimuli. Phase 3 involved a mix of all trials from Phases 1 and 2 presented in random order. Each trial type was presented twice for a total of 12 trials in each trial block. Participants were required to correctly match 10 out of the 12 trials. After reaching the criterion responding level on phase 3, participants were exposed to testing for equivalence class formation.

Thirty test trials were conducted in random order to test for derived relations between the B and C stimuli. During testing, each ‘B’ stimulus was presented as the sample five times with the ‘C’ stimuli presented as comparisons. Likewise, each ‘C’ stimulus was presented as the sample five times with the ‘B’ stimuli as comparisons. When the 30 test trials were completed, the following message appeared on the screen:

DONE! Thank you for your participation in this experiment. Please contact the experimenter for the final questionnaires and a debriefing about the experiment before you go.

When the participants completed the MTS procedure, they again completed the Test for Stimulus Functions. The experimenter then debriefed them and collected information necessary for reporting extra credit to their professors before they exited the lab.

Results

Three hundred sixty-one screening packets were returned to the lab for analysis. Of the 361 participants who completed the screening measures, 162 met distress criteria for inclusion in the experiment. Sixty participants, thirty in each distress group returned to the lab for completion of the experimental procedures.

Mood and affect changes following the interview process. The participants’ mood changes during the interview process were of interest due to the fact that level of distress was an independent variable in the analyses. If the participants’ levels of distress varied after the interview process it was suspected that the interview induced a particular mood state. A decrease in positive affect or an increase in negative affect following the interview process could indicate that the interviewer successfully captured a personally relevant stressor to be used as the PERSONAL stimulus. Also, affect was evaluated to determine if levels of distress changed differentially for the distress groups. There are two reasons for evaluating differential changes in affect. First, if negative affect changed differentially between groups this may indicate that state distress caused the difference in task performance, rather than more global distress as measured by the OQ-45. Second, this change could indicate between group differences in class formation that are not accounted for by distress group. Therefore, it was considered that affect should be further evaluated as a covariate in the main hypothesis testing. Thus, PANAS scores were compared via 2 (distress group) x 2 (pre/post) mixed ANOVA to determine if the interview process had an effect on the individuals’ affect. For Positive Affect, a significant interaction between time and distress group was noted, $F(1, 58) = 4.489$, $p = .038$, $\eta^2 = .118$, indicating that the groups’ positive affect changed differentially following the interview. Paired samples t-tests indicated that the HD Group significantly decreased in positive affect following the interview, $t(1, 29) = 3.680$, $p = .001$, but the LD Group did not,

t (1, 29) = -.446, *p* = .659. For Negative Affect, there was a significant main effect of group, F (1, 58)=39.435, p=.000, η^2 = .405, and time, F (1, 58) = 6.898, *p* = .011, η^2 = .106, indicating that the HD group reported more negative affect than the LD Group and that for both groups negative affect increased following the interview. In sum, the interview effected affect for both groups. Negative affect increased for both groups, but positive affect changed differentially for the groups. Positive affect increased nonsignificantly in the LD Group, but decreased significantly for the HD Group. Because negative affect significantly increased across groups, it was assumed that the interviewer was successful at summarizing participant distress for inclusion in the experiment. Because negative affect did not differentially change across distress groups, it was not deemed necessary to statistically control for the state negative affect in subsequent analyses.

To test the effects of distress on responding across classes of stimuli, a 2 (distress group) x 3 (equivalence class) mixed ANOVA with Bonferroni corrections was conducted with the number of correct responses on testing trials as the dependant variable. No significant effects were detected; however, there was a trend toward a main effect of group, suggesting that the HD Group had more difficulty overall in forming equivalence classes, F (1, 59) = 3.500, *p* = .063 η^2 =.058. These results fail to support both Hypothesis 1 and 2. No significant differences between classes were detected in number correct on the equivalence testing trials, indicating that people did not derive relations more readily when personally relevant stimuli were included. No significant interaction between class and group was detected, indicating that people with high distress did not form equivalence classes with personally relevant stimuli more readily than those with low distress.

Because there was a trend toward the HD and LD Groups performing differentially on the test for equivalence, it was hypothesized that the groups may differ on their reported stimulus function. Therefore, the test for stimulus function was again examined using 2 (distress group) x 2 (time) x 3 (class) mixed ANOVA's for each of the sub-scale scores. Bonferroni corrections for the family of ANOVA's reset the alpha levels to .0125. Below, results from each of the "function" variables are discussed.

Emotional. There was a significant main effect of time, F (1,58) = 27.703, *p* = .000, η^2 = .323, indicating the emotional functions of all stimulus classes increased significantly following the equivalence training in both distress groups. There was a significant main effect of group, F (1, 58) = 14.040, *p* = .000, η^2 = .195, indicating that the HD Group (*M* = 10.14, *SE* = .29) reported significantly more emotion overall than the LD Group (*M* = 8.61, *SE* = .29). There was a significant main effect of class, F (2, 116) = 32.963, *p* = .000, η^2 =362, indicating that there were significant differences between the classes. Pairwise comparisons with Bonferroni corrections were examined to determine the differences between classes. The emotional function of the Personal Class (*M* = 10.07, *SD* = .21) was significantly greater than both the Negative (*M* = 9.62, *SD* = .22), *p* = .013, and the Neutral Classes (*M* =8.44, *SD* = .27), *p* = .000. The emotional function of the Negative Class was also significantly greater than the Neutral Class, *p* = .000.

These results show that the interaction between time and class was significant, F (2,116) = 5.508, *p* = .011, η^2 = .087, indicating that the classes changed differentially over time. Paired samples t-tests were conducted to determine if each class differed across time. Results indicated that there were

significant increases in emotional valence over time for the Personal Class, t (1, 59) = -5.95, p = .000, and Negative Class, t (1,59) = -4.523, p = .000, but not the Neutral Class, t (1, 59) = -1.634, p = .108. The interaction between class and group, F (2, 116) = 3.467, p = .044, η^2 = .056, fell just below the significance level, but trended toward indicating that the distress groups responded differentially per class. The interactions between time and group, F (1, 58) = 2.68, p = .108, η^2 = .044, and time, group and class were not significant, F (2, 116) = .905, p = .383, η^2 = .015.

Pleasant. There was only a significant main effect of class, F (2, 116) = 23.017, p = .000, η^2 = .284. This result was to be expected, and it indicates that the stimuli were differentially pleasant. Pairwise comparisons with Bonferroni corrections were conducted revealing that the Negative class (M = 7.14, SE = .158) was significantly less pleasant than the Personal (M =8.37, SE = .244), p = .000, or Neutral (M =9.16, SE = .277), p = .000. However, the Personal and Neutral classes did not differ significantly on pleasant function, p = .096. There was no significant main effect of time, F (1, 58) = .263, p = .610, η^2 = .005, or group, F (1, 58) = 2.056, p = .157, η^2 = .034. There was not a significant interaction between time and distress, F (1, 58) =1.778, p = .188, η^2 = .030, class and distress, F (2, 116) = .731, p = .458, η^2 = .012, time and class, F (2, 116) = 2.270, p = .118, η^2 = .038, or time, group, and class, F (2, 116) = 1.894, p = .163, η^2 = .032.

Meaning. There was a significant main effect of time, F (1, 58) = 66.399, p = .000, η^2 = .534, indicating that meaning of the stimuli significantly increased following the MTS task. There was also a significant main effect of group, F (1, 58) = 13.483, p = .001, η^2 = .189, indicating that the HD Group reported more meaning across all stimuli than did the LD Group. There was a significant main effect of class, F (2, 116) = 30.578, p = .000, η^2 = .345. Pairwise comparisons with Bonferroni corrections were conducted and revealed that the Personal Class (M =10.82, SE = .223) was significantly more meaningful than the Negative (M = 9.53, SE = .224), p= .000, or Neutral (M =9.28, SE = .239), p= .000, Classes, but the Negative and Neutral Classes were not significantly different than each other, p= .720. In sum, meaning of the stimuli in the respective classes changed following the MTS task, the meaning of the stimuli were different per class, and the meaning of the stimuli were more meaningful to the HD group than the LD group at both time points. There were no significant interactions detected between time and group, F (1, 58) = 2.680, p= .107, η^2 = .044, class and group, F (2, 116) = 1.124, p = .324, η^2 = .019, time and class, F (2, 116) = .344, p = .706, η^2 = .006, or time, group and class, F (2, 116) = .037, p = .962, η^2 = .001.

Familiarity. A significant main effect of time, F (1, 58) = 154.326, p = .000, η^2 = .727, was revealed, indicating that the participants' familiarity with the different stimuli increased following the MTS task. There was a main effect of class, F (2, 116) = 37.412, p = .000, η^2 = .392. Pairwise comparisons with Bonferroni corrections were conducted revealing that the Personal class (M =11.85, SE = .213) was significantly more familiar than the Negative (M =10.47, SE = .210), p = .000, or Neutral (M = 10.73, SE = .247), p = .000, but the Negative and Neutral Classes were not significantly different than each other, p = .348. There was no significant main effect of distress group, F (1, 58) = 5.056, p = .028, η^2 = .080. There were trends toward interactions between class and distress group, F (2, 116) = 4.285, p = .017, η^2 = .069, and time and class, F (2, 116) = 3.637, p = .036, η^2 = .059, indicating that the distress groups may have responded differentially to the stimuli and that the classes may have changed

differentially over time. Also, there were no significant interactions between time and distress, F (1, 58) = 3.708, p = .059, η^2 = .060, or time, group and class, F (2, 116) = 2.426, p = .101, η^2 = .040. These data suggest that the inclusion of distress group into the analyses was not helpful in detecting changes or differences in the data. No results from the initial test of hypothesis 3 were changed when distress group was added as a factor. Participants with varying levels of distress reported only Emotion and Meaning functions differentially.

Discussion

Previous research in the area of derived relational responding has suggested two factors that may be important in the formation of equivalence classes: (a) the participants' level of distress and (b) the relevance of the stimuli to the individual. The present study sought to explore how these proposed factors impacted the behavior of relating.

It was hypothesized that the content of the words in the word sets would have an effect on responding such that stimuli, which were personally relevant to the individual, would acquire novel members to its class more readily than the generally negative emotion words or the neutral words. However, no effect of content of the word sets on deriving relations was found. These results are inconsistent with previously reported results. Both Wilson (1998) and Adcock et al. (in press) reported facilitated acquisition of the personally relevant stimulus class by participants who were in treatment for substance abuse or struggling academically, respectively. Reasons for the failure to replicate the facilitation effect with personal stimuli are unclear in the current study. One possibility is that studies in which a facilitation effect was found studied the effect in specifically distressed populations with stimuli linked directly to the specific domain of distress. In contrast, the current study examined more general distress, not a particular behavior problem. As such, results may suggest that facilitated acquisition with personally relevant stimuli only occurs within the context of a well-defined and specific area of distress (Wilson, 1998; Adcock et al., in press).

Not all studies have suggested that high distress facilitates acquisition. In fact, other studies have reported decreased equivalence class formation in clinical populations such as anxious individuals (Leslie et al., 1993), phobics (Plaud, 1995), and those with low self-esteem (Merwin & Wilson, 2005). Although the current study failed to replicate this inhibitory effect with generally distressed individuals, a trend in the direction of supporting such findings was found.

One possible explanation for emerging differences in equivalence class acquisition is the differential transformation of stimulus functions across HD and LD Groups. If the HD Group experiences more distress when presented with the stimulus, this heightened level of distress may decrease flexibility in responding. Thus, participants experiencing greater levels of emotionality when contacting the now aversive stimuli may simply have been making a response to remove the stimuli from the screen rather than responding based on previously trained relations.

To further explore whether changes in stimulus functions due to the MTS procedure led to facilitated or inhibited acquisition, participants were asked to rank how pleasant, meaningful, familiar, and emotional each stimulus was both before and after the MTS task. If it is possible that emerging

changes in stimulus functions led to facilitated or inhibited acquisition, two finding should emerge. First, the functions should transform differentially across groups, and second, changes in function should significantly correlate with accuracy on the equivalence test. Although emotional, meaning, pleasant, and familiar functions transformed through classes due to training, it is interesting to note that these transformations of functions did not occur differentially across groups.

Likewise, only one of the correlations between stimulus function and accuracy on the equivalence test was significant (see Table 3). Combined, these results suggest that the change in stimulus function was not related to task performance in this sample. This finding is interesting because equivalence class formation has been defined by some researchers as the combination of certain elements including symmetry, transitivity, and the transformation of stimulus functions (Hayes, et al. 2001). Given this definition, it is difficult to understand how stimulus function could change independently of the appearance of transitive relations.

Table 3.

Correlations of Function Ratings and Number Correct on Equivalence Testing Trials.

	Stimulus Function				Equivalence Test		
	Emotion	Pleasant	Meaning	Familiar	Personal	Negative	Neutral
Emotion	--	-.039	.516**	.059	.175	.015	.043
Pleasant		--	.106	-.035	-.176	-.182	-.209
Meaning			--	.262*	.149	.060	.013
Familiar				--	.155	.290*	.045
Personal					--	.574**	.620
Negative						--	.697**
Neutral							--

$p < .05$. ** $p < .01$.

Limitations and Future Directions

Although this study attempted to clarify issues with respect to equivalence class formation, there were a number of limitations. First, distress was measured at a variable time prior to equivalence class

formation testing. The OQ-45 was given as a packet to be completed at the participants' leisure and we cannot be sure that it was returned to the lab immediately upon completion. Given this, scheduling and other issues may have extended the time between completion of the OQ-45 and laboratory testing. The OQ-45 is intended to measure distress within 2 weeks, thus care must be taken to consider that participant's level of distress may have changed prior to entering the lab. However, immediately upon entering the lab, the participant completed the PANAS using the at the moment version of the instructions to determine the participant's mood and affect. Negative Affect scores from the PANAS were significantly correlated with OQ-45 scores ($r = .558$, $p = .01$), thus it is likely that the HD Group remained distressed, and the LD Group remained non-distressed. This limitation was further explored by re-running the main analysis of variance with the post treatment negative PANAS score as a covariate. When this was done, none of the results differed from the original analysis. However, the OQ-45 is designed to measure distress over the past two weeks, not trait distress, and the PANAS used in this study was only designed to measure levels of affect in the moment. It is expected that the individuals continuing to report high levels of negative affect possibly exhibited distress as a trait, thus future research could also examine the issue of state verses trait forms of distress and its effect on derived relational responding. The participants with state forms of distress due to some life experience may have made the results of the current research somewhat unclear.

Another limitation of this study was the focus on external validity, which in turn sacrifices the internal validity with respect to two main study items. First, the study stimuli were participant chosen words that described personal struggles, rather than some experimentally determined function. Next, there were possible effects of social desirability and experimenter bias on stimulus choice. Experimenters interviewed each participant and summarized events, thoughts and feelings occurring for the participant at that time in their lives. It is possible that certain people did not feel comfortable enough to speak freely with the experimenter about truly distressing events in their lives, and this could have affected the experimenter's ability to adequately choose the most distressing personal stimulus. The choice of a less than adequate personal stimulus could have affected the results of the content of the stimulus test. Future research could address this limitation of the current study due to human interaction by using only the negative emotion words and comparing them to both neutral and arbitrary class formation. Another possible alteration of the current study would be to determine if there are differential acquisition rates of positive verses negative emotion words to arbitrary classes of stimuli. This would allow further evaluation of the role of content in derived relational responding without the potential for human error.

Additionally, many of the participants in this study scored perfectly on the test for equivalence class formation. This ceiling effect may have been the cause for the null findings of class differences. To explore the possibility that removing the participants who scored perfectly on the equivalence test, the first two hypotheses were tested again without those subjects included. Results indicated that the exclusion of the perfect responders did not impact the earlier conclusions. However, more participants from the HD Group were excluded, thus making unequal variances in the groups. Thus, future research may address the ceiling effect by limiting the number of training trials, for example, by removing the mixed training (AB, AC) trials, as limiting training should produce more variability in responding on testing trials. Another possible solution would be to add more testing trials yielding more responses to examine, thus adding variability. Finally, to further address the unequal variance related to number of

participants deriving relations, intellectual capacity could be measured and controlled for in future research to insure that intelligence is not creating the difference or lack thereof.

Conclusion

More research is needed to determine the different variables that support and maintain verbal learning. The research in derived relational responding is a firm beginning. There are contradictory results reported, and those contradictions should be clarified in future studies with the aforementioned controls to determine if the content of the stimuli being related is important.

References

Adcock, A. C. et al., (in press). The problem isn't learning: Facilitated acquisition of stimulus equivalence classes among low achieving college students. *The Psychological Record*.

Barnes, D., Lawlor, H., Smeets, P. M., & Roche, B. (1996). Stimulus equivalence and academic self-concept among mildly mentally handicapped and nonhandicapped children. *The Psychological Record*, 46, 87-107.

Barnes-Holmes, Y., Barnes-Holmes, D., Smeets, P. M., Luciano C. (2004). A derived transfer of mood function through equivalence relations. *The Psychological Record*, 54, 95-113.

Barnes-Holmes, D., Keane, J., Barnes-Holmes, Y., & Smeets, P. M. (2000). A derived transfer of emotive functions as a means of establishing differential preferences for soft drinks. *The Psychological Record*, 50, 493-511.

Devany, J. M., Hayes, S. C., & Nelson, R.O. (1986). Equivalence class formation in language-able and language-disabled children. *Journal of Experimental Analysis of Behavior*, 46, 243-257.

Dougher, M. J., Augustson, E., Markham, M. R., Greenway, D. E., & Wulfert, E. (1994). The transfer of respondent eliciting and extinction functions through stimulus equivalence classes. *Journal of the Experimental Analysis of Behavior*, 62, 331-351.

Hayes, S. C., Barnes-Holmes, D., & Roche, B. (2001). *Relational Frame Theory: A Post-Skinnerian Account of Human Language and Cognition.* New York, NY: Kluwer Academic / Plenum Publishers.

Lambert, M. J., Hansen, N. B., Umphress, V., Lunnen, K., Okiishi, J., & Burlingame, G. M. (1997). *Administration and scoring manual for the OQ-45.2*. Maryland: American Professional Credentialing Services LLC.

Leslie, J. C., Tierney, K. J., Robinson, C. P., Keenan, M., Watt, A., & Barnes, D. (1993). Differences between clinically anxious and non-anxious subjects in a stimulus equivalence training task involving threat words. *The Psychological Record*, 43, 153-161.

Lipkins, R., Hayes, S. C., & Hayes, L. J. (1993). Longitudinal study of the development of derived relations in an infant. *Journal of Experimental Child Psychology*, 56, 201-239.

Matthews, B. A., Shimoff, E., Catania, A. C., & Sagvolden, T. (1977). Uninstructed human responding: Sensitivity to ratio and interval contingencies. *Journal of the Experimental Analysis of Behavior*, 27, 453-467.

Merwin, R. M & Wilson, K. G. (2005). Preliminary findings on the effects of self-referring and evaluative stimuli on stimulus equivalence class formation. *The Psychological Record*, 55, 561-575.

Moxon, P. D., Keenan, M., & Hine, L. (1993). Gender-role stereotyping and stimulus equivalence. *The Psychological Record*, 43, 381-394.

Peoples, M., Tierney, K. J., Bracken, M., & McKay, C. (1998). Prior learning and equivalence class formation. *The Psychological Record*, 48, 111-120.

Plaud, J. J. (1995). The formation of stimulus equivalences: Fear-relevant versus fear-irrelevant stimulus classes. *The Psychological Record*, 45, 207-222.

Plaud, J. J., Gaither, G. A., Franklin, M., Weller, L. A., & Barth, J. (1998). The effects of sexually explicit words on the formation of stimulus equivalence classes. *The Psychological Record*, 48, 63-79.

Roche, B. & Barnes, D. (1997). A transformation of respondently conditioned stimulus function in accordance with arbitrarily applicable relations. *Journal of the Experimental Analysis of Behavior*, 67, 275-301.

Smeets, P. M., & Barnes-Holmes, D. (2003). Children's emergent preferences for soft drinks: Stimulus equivalence and transfer. *Journal of Economic Psychology*, 24, 603-618.

Watson, D., Clark, L. E., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *The Journal of Personality and Social Psychology*,54, 1063-1070.

Watt, A., Keenan, M., Barnes, D., & Cairns, E. (1991). Social categorization and stimulus equivalence. *The Psychological Record*, 41, 33-50.

Wilson, K. G. (1998). *Relational acquisition of stimulus function in substance dependence: A preliminary examination of drug versus non-drug related equivalence classes*. Unpublished doctoral dissertation, University of Nevada, Reno.

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