**A Preliminary Examination of Derived Relational Responding in the Context of Body Image**

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**Abstract**

Relational Frame Theory (RFT), a contemporary behavioral account of language and cognition, has been offered as an explanatory model of the development and maintenance of body image disturbance. RFT posits derived relational responding (DRR) as a process through which the impact of an event on behavior changes absent direct contingency learning, and in accordance with relations with other events. Conceptual work has assumed DRR as central to the development and treatment of body image disturbance. This study offers the first empirical investigation of DRR with body image stimuli, and untrained approach and escape functions. Participants readily demonstrated mutual and combinatorial entailment with stimuli they generated to represent their own body image, along with images fatter and thinner than themselves. Participants also readily demonstrated transformation of untrained approach and escape functions consistent with that of thinner and fatter body images. These findings provide a preliminary demonstration of DRR in the context of body image disturbance and support further research applying RFT in this area.

*Keywords:* Body image; Relational Frame Theory; Derived Relational Responding; Operant Conditioning; Learning; Body Dysmorphic Disorder

**A Preliminary Examination of Derived Relational Responding in the Context of Body Image**

Body image can be defined as an individual’s total experience of his or her physical self (Cash, 2004). Disruptions in body image, referred to as *body image disturbance* (BID), are seen in all aspects of the body experience: 1) perceptual, 2) attitudinal, and 3) behavioral (Thompson, Heinberg, Altabe, & Tantleff-Dunn, 1999), and are associated with significant dysfunction. BID is included as a primary clinical feature for Body Dysmorphic Disorder, Anorexia Nervosa, and Bulimia Nervosa (American Psychiatric Association, 2013). In addition, BID is associated with other psychological difficulties including anxiety disorders (e.g., Simeon, Hollander, Stein, Cohen & Aronowitz, 1995), mood disorders (e.g., Downs, DiNallo, & Kirner, 2008), and personality disorders (e.g., Cohen et al., 2000). BID also predicts dysfunction in terms of social functioning (e.g., alienation and conflict; Schutz & Paxton, 2007) and poor physical health (e.g., Muennig, Jia, Lee, & Lubetkin, 2008).

Continued scientific progress in addressing and preventing BID depends on increased understanding of its development and maintenance. A traditional behavioral account, for example, would emphasize the roles of respondent and operant conditioning in the development of the emotional and overt behavioral components of BID (Neziroglu, Khemlani-Patel, & Veale, 2008b). Attending to the body in close spatiotemporal proximity with a stimulus that occasions negative emotions would result, through respondent conditioning, in the body itself eliciting said emotional reaction. For example, if a parent exhibited disgust upon seeing a child’s stomach, the child would likely experience shame, not only in that moment, but also following subsequent exposures to their stomach. In addition, the response just prior to the negative emotion would, through operant conditioning, decrease in probability. For example, if the child had lifted their shirt to show the parent a bug bite, they would be less likely to lift their shirt again after it resulted in the parent’s disgust. Also, through operant conditioning, responses to the negative emotions elicited by the body, would, either increase or decrease in probability depending on their consequence. If the child felt shame, responded by changing into a baggy shirt, and felt relief from that shame, the probability of wearing baggy clothes would increase due to negative reinforcement.

A traditional behavioral account, however, is limited, in two ways. First, not all the problems that comprise BID can be traced to specific instances of respondent or operant conditioning. Instead, it seems that with BID, seemingly innocuous events (e.g., the shape of a body part, a discarded piece of clothing, mention of a pool party, a number on a scale) can come to elicit extreme distress or relief, and to occasion rigid avoidance or pursuit. For example, the child in the previous example may, without additional learning, come to feel shame upon seeing any part of her body uncovered, even those parts that bear no physical similarity to the stomach (e.g., the feet), and subsequently cover those parts, as well. She may even feel shame upon being invited to a friend’s sleepover, as sleeping involves wearing pajamas, and wearing pajamas involves undressing. Even though her friend has never been a source of shame, it would not be surprising if she avoided the sleepover to avoid her body shame. This brings up a second limitation. A traditional behavioral account such as that provided above does not directly address the cognitive components of body image, which are key targets in the most well-supported treatments for BID (see Jarry & Berardi, 2004). Neziroglu and colleagues (Neziroglu et al.,2008b; Neziroglu, Roberts, & Yaryura-Tobias, 2004) have expanded upon a traditional behavioral account, employing Relational Frame Theory (RFT) as a putative explanatory model for how verbal learning experiences contribute to the development and maintenance of BID.

Relational Frame Theory (RFT; see Hayes, Barnes-Holmes, & Roche, 2001) offers a behavioral account of language and cognition that suggests that symbolic behavior could be considered instances of *derived relational responding* (DRR), or responding to one stimulus in accordance with its relation with another stimulus. Symbolic behavior (e.g., avoidance of apparently unrelated or directly trained stimuli) seems particularly salient in the context of BID as persons with BID tend to approach or avoid stimuli for which there is no clearly identifiable body image related link or learning history. For example, the person who hears the saying, “you can never be too rich or too thin,” may learn, (without ever having been thin) to relate being thin to being rich, and to respond accordingly (e.g., by dieting or by feeling excited about losing weight). DRR is not independent of direct conditioning processes. In fact, it seems DRR emerges through the operant conditioning processes which generalize to be applied in novel situations (Healy, Barnes-Holmes, & Smeets, 2000). While learning language, relating (e.g., relating a spoken label to the object itself) is repeatedly reinforced with a number of different stimuli in different situations, the individual will come to readily relate any two stimuli, the response to either being informed by the relation amongst the two (Lipkens, Hayes, & Hayes, 1993). In other words, RFT suggests that, in learning language, humans learn to respond to events in the world not only through direct contingency learning (i.e., events becoming conditioned stimuli through respondent conditioning, or discriminative stimuli through operant conditioning), but through their relations to other events (for detailed discussions of clinical relevance of basic research in RFT see Guinther & Dougher, 2015; McLoughlin, Tyndall, Mulhern, & Ashcroft, 2019).

Indeed, a substantial body of evidence (see Dymond, May, Munnelly, & Hoon, 2010) supports that once DRR is established as generalized operant behavior, stimuli can acquire and change functions (i.e., can become conditioned stimuli, discriminative stimuli, or consequating stimuli) with extremely limited prior experience, simply as a result of their having been related to other stimuli. While the early literature in this area focused on relations of sameness or coordination (see Sidman, 1994), stimuli can be related in a number of ways beyond simple coordination (e.g., thin *is the same as* beautiful). These include comparison (e.g., Zuri *is prettier than* me; Barnes-Holmes, Barnes-Holmes, Smeets, Strand, & Friman, 2004; Berens & Hayes, 2007), opposition (e.g., acne *is the opposite of* attractive; Barnes-Holmes, Barnes-Holmes, & Smeets, 2004; Whelan & Barnes-Holmes, 2004), hierarchy (e.g., clear skin and shiny hair *are part of* what makes beauty; Gil, Luciano, Ruiz, & Valdivia-Salas, 2012; Griffee & Dougher, 2002; Slattery & Stewart, 2014) and more (see Dymond & Barnes, 1994, 1995, 1996; Roche & Barnes, 1996, 1997; Steele & Hayes, 1991). DRR, then, is offered as one promising behavior analytic account of human language and cognition with clear implications for how it is that stimuli come to control behavior despite little or no direct learning history with such stimuli (see Dymond & Roche, 2013 for a review).

DRR is typically described in terms of three properties – mutual entailment, combinatorial entailment, and transformation of function – each independently sensitive to contextual control (Hayes et al., 2001). Mutual entailment means that if a person learns to relate two things (e.g., thin *is the same as* beautiful) in a particular way in a particular context, they will also derive the reverse relation in that context (e.g., beautiful *is the same as* thin). Combinatorial entailment means that if a person learns to relate two pairs of stimuli with a shared member (e.g., thin *is the same as* beautiful, and beautiful *is the same as* good) in particular ways in a particular context, they will derive relationships between the unshared members (e.g., therefore, thin *is the same as* good). Finally, transformation of function describes how the function of one event (i.e., how that event impacts behavior) is transformed based on the functions of another event to which it is related. For example, for the person who has learned to relate as above, thinness would likely serve to reinforce any behavior it followed, and to elicit excitement or pride. Likewise, if the person relates fat and thin as opposites, the person could derive that fat *is the same as* ugly and bad, and fatness would punish any behavior it followed and elicit dread or shame. Once this relational framing repertoire was established, any events that the person learned to relate to thin or fat, beautiful or ugly, good or bad could come to elicit strong feelings or avoidance or approach behavior. Data demonstrate transformation of functions of a number of different sorts in different contexts (Dymond & Rehfeldt, 2000; Perez et al., 2017) including, but not limited to, conditional reinforcement and punishment (Hayes, Kohlenberg, & Hayes, 1991; Greenway, Dougher, & Wulfert, 1996), avoidance and fear elicitation (Amd, Barnes-Holmes, & Ivanoff, 2013; Dougher et al., 1994; Roche, Kanter, Brown, Dymond, & Fogarty, 2008), discrimination (Dougher, Hamilton, Fink, & Harrington, 2007), and emotion (Amd & Roche, 2016).

RFT has been offered as a theoretical account of how DRR complements respondent and operant conditioning processes in the development and maintenance of BID in the context of BDD (Neziroglu et al., 2004; Neziroglu et al., 2008b). This model could have direct implications for prevention and treatment of BID. For example, behavioral treatments target body image avoidance BID through exposure-based procedures, with mixed results (e.g., mirror-based exposure; Griffen, Naumann, & Hildebrandt, 2018). These treatments rely on operant and respondent extinction processes to reduce arousal and avoidance in the response to the body.

Despite potentially important implications of RFT for understanding BID, DRR has not been empirically investigated in the context of body image. In fact, to our knowledge only one study has examined DRR with self-relevant stimuli (i.e., “me,” “myself,” “I”; Merwin & Wilson, 2005) and arbitrary stimuli. Further, transformation of function has been demonstrated only with experimentally-induced functions (e.g., directly conditioning a stimulus to serve as a reinforcer, then demonstrating transformation of functions of related stimuli to also serve as reinforcers). If RFT is to be applied to understanding of how body image dissatisfaction can cause such diffuse difficulties as are associated with BID, it should be demonstrated that 1) people easily learn to relate body image stimuli (including self-relevant stimuli) to arbitrary stimuli, and that 2) the functions of arbitrary stimuli are transformed in accordance with the functions of body image stimuli and the relations between them, whatever those functions may be.

The current study explored precisely these two hypotheses, examining three properties of DRR – mutual entailment, combinatorial entailment, and transformation of function – with participant-specific body image stimuli and untrained approach and escape functions to those stimuli. With regard to transformation of function, approach and escape responses were chosen due to the important role avoidance has in maintaining BID (see Cash, 2004; Thompson et al., 2009).

Thus, the overarching aim of the current study was to examine whether participants would derive symbolic relations between body image stimuli and previously neutral stimuli, in that the functions of body image stimuli (appetitive or aversive) would transfer to stimuli via a relational network without a direct conditioning or learning history. Such a demonstration would add to our understanding of how seemingly innocuous stimuli that appear unrelated to body image can come to serve or evoke the range of problematic behaviors (e.g., eating restriction, avoidance of physical intimacy, or social withdrawal) typically evoked by actual body image stimuli, a pattern that typified BID. This might help clinicians working with clients with BID understand and appreciate how these problematic behaviors emerge in novel and seemingly unrelated contexts where such behavior has not been directly conditioned or reinforced. This could have potential implications for how a clinician might choose to compose a case formulation and treatment plan for a particular client. Specifically, it was hypothesized that 1) participants would demonstrate mutual and combinatorial entailment amongst participant-specific body image stimuli and arbitrary stimuli, and 2) participants would demonstrate transformation of untrained functions of arbitrary stimuli consistent with the body image stimuli to which they have been related.

**Methods**

**Participants**

The sample included 34 female undergraduate students recruited from a southern university in the United States. Participants were provided course credit in exchange for their participation. The average age of the sample was 18.91 years (SD = 1.62) with 71% self-identifying as White/Caucasian, 18% as African American, 6% as Multiracial/Other, 3% as Hispanic/Latino, and 3% as Asian/Asian-American.

**Apparatus and Setting**

Nine Dell Optiplex 755 computers, outfitted with 2200.0 MHz Intel Core 2 Duo E4500 processors, were used along with their 15×12 inch monitors, keyboard, and mouse. Instructions and stimuli were displayed on the monitor, and all responses were recorded to a Microsoft Access database. The computer task was designed using Visual Basic 2008.

Participants completed the computer task in a 25’ by 30’ computer laboratory, isolated from noise and other distractions, Participants were seated at desks with privacy screens (30” wide, 15” tall, and 22” deep), and the computers used for the study were arranged such that every other desk was empty.

**Approach-avoidance task (AAT; Rinck & Becker, 2007)**. An AAT task was employed and designed to approximate approach and escape responses with all nine stimuli. The AAT is commonly used in assessment of responses to threat, and has performed as well or better than other automated behavioral measures (i.e., “implicit” measures) of the same, both in terms of reliability and validity (Reinecke, Becker, & Rinck, 2015). The AAT was, for this study, adapted to use button presses instead of joystick, such that escape and approach were operationalized as a series of discrete responses (Becker, 2017). “Approaching” stimuli involved pressing the J button on the keyboard, resulting in the increasing the stimulus size from 300 pixels by 30 pixels per response. “Escaping” stimuli involved pressing the F button, resulting in the stimulus being reduced in size, from 300 pixels, by 30 pixels per response. Participants could increase the size of stimuli to a maximum size of 600 pixels and could decrease the size of the stimuli until it no longer remained on the screen. Additionally, once a response was selected (i.e. either escape or approach) the other response option was no longer available, so that participants could only exhibit escape or approach responses in each trial.

**Measures**

**Body Image-Acceptance and Action Questionnaire (BI-AAQ).** The BI-AAQ is a 12-item, seven-point Likert scale measure of body image flexibility, with higher scores indicating greater psychological flexibility regarding body related psychological experiences (Sandoz, Wilson, Merwin, & Kellum, 2013). The BI-AAQ has demonstrated good reliability, construct validity, and discriminant validity in both community and clinical samples (Basarkod, Sahdra, & Ciarrochi, 2018; Lee et al., 2017; Sandoz et al., 2013).

**Body Image Avoidance Questionnaire (BIAQ).** The BIAQ is a 19 item, six-point Likert scale measure of avoidance of situations associated with body imagine concern, with higher scores indicating greater frequency of avoidance (Rosen, Srebnick, Saltzberg, & Wendt, 1991). The BIAQ enjoys strong evidence of reliability and validity (Pellizzer, Tiggemann, Waller, & Wade, 2018; Rosen et al., 1991)

 **Body Image Quality of Life Inventory (BIQLI).** The BIQLI is a 19-item, seven-point bipolar scale measure of quality of life, with scores ranging from -57 to 57 (Cash & Fleming, 2002). Negative scores indicate negative effects of body image on quality of life while positive score indicate positive effects. The BIQLI has strong evidence of reliability and validity in college student populations (Cash & Fleming, 2002; Cash & Grasso, 2005).

**Procedure**

All participants provided written consent following a description of the study’s tasks, risks and benefits, compensation, and right to withdraw. Participants then completed a battery of self-report measures, including the BI-AAQ, BIAQ, and BIQLI. Computerized data collection proceeded in three phases.

**Phase 1: Stimuli selection**. Participants engaged in a body image assessment task using the Body Image Assessment Software (BIAS; Ferrer-Garcia & Gutierrez-Maldonado, 2008). The BIAS presented frontal and profile representations of a scale female body and instructions to click + or – buttons to modify six body parts (head, arms, breast, waist, hips, and legs) to represent their own body. Specifically, instructions read, “On the screen you will see a silhouette of a female figure in frontal view and in profile. Your task is to modify (if necessary) each of the part of the figure so that it conforms as far as possible to your real body image (“what I look like”). Select the part you want to modify by placing the cursor over the list on the right of the screen. When you have made your choice, increase the size by clicking on “+” and reduce it by clicking on “-“. Above the list of parts of the body you will find the precision scale (wide, normal, thin). Using this command you can control the size of the increases or reductions that you make. If you choose “wide” the increases and reductions will be bigger but less detailed; if you choose “normal” or “thin” they will be smaller, but more precise. Remember that the frontal view and the profile are modified independently of each other, so you must select one of the options before making your changes to the body. Take as long as you like, and be as accurate as you can. If you have any questions, please ask. When you finish, click on “enter.”

Once the participant was satisfied with the image, the experimenter saved that image (i.e., the “self” image) along with one “fatter” and one “thinner” image for use in the remainder of the experiment (the B stimuli). The “fatter” and “thinner” images were made for each participant using a consistent pattern of clicks in the BIAS program: head (frontal ±1, profile ±1), arms (frontal ±1, profile ±0), breast (frontal ±2, profile ±1), waist (frontal ±2, profile ±1), hips (frontal ±2, profile ±2), and legs (frontal ±1, profile ±2).

**Phase 2: Matching-to-sample.** After stimulus selection, participants engaged in a matching-to-sample conditional discrimination task training three three-member relational sets. Each set included one of three participant-specific body image stimuli (i.e., “fatter,” “self,” and “thinner;” denoted here as B stimuli) and two of six nonsense syllables (i.e., NAK, MIP, KAZ, PID, SOJ, and BEX; denoted here as A and C stimuli). See Figure 1 for graphical depictions of A and C stimuli and a representative example of B stimuli. Conditional discrimination training consisted of a stimulus at the top of the screen (A1, A2, or A3) and three comparison stimuli across the bottom of the screen (B1, B2, and B3 or C1, C2, and C3) presented simultaneously. No orientating response was required and a 1.5 second inter-trial interval (ITI) was programmed between trials. Participants were given the following instructions prior to the task: “When this experiment begins, images will appear on the computer screen. One image will appear at the upper middle of the screen, and three additional images will appear at the lower left, lower middle, and lower right of the screen. Your task is to choose the correct image from among those in the lower portion of the screen. In this experiment you will choose just one image on each trial. To do this, simply click on whichever of the three lower images you believe to be correct. During some parts of the experiment you will be given feedback after your selections and during other parts you won't receive any feedback. However, there is always one correct answer. The more accurate you are, the less time this experiment will take. Please ask the experimenter if you have any questions. When you are ready click Continue.” During training, selection was followed by the presentation of the words, “correct” or “incorrect” on the screen during the 1.5 second ITI. During testing, selection was followed by a blank screen for the 1.5 second ITI (i.e., responses during testing had no programmed consequences).

There were five phases in the conditional discrimination procedure including three phases directly training conditional discriminations and two phases testing for the emergence of mutual and combinatorial entailment. The first stage directly trained A-B relations of coordination (A1-B1, A2-B2, A3-B3), and the second stage directly trained A-C relations of coordination (A1-C1, A2-C2, A3-C3). For both stages, participants had to correctly complete 16 out of 18 trials (89%) to move on to the next stage. The third stage was a mixed training including both A-B and A-C relations. In this stage 32 of 36 trials (89%) had to be completed correctly for participants to move on to testing.

Next, relational testing probed for mutual entailment of derived B-A and C-A relations, and combinatorial entailment of C-B/B-C relations. Testing criterion was 16/18 trials (89%) for both testing stages. If participants did not meet criterion for combinatorial entailment, they returned to the mixed A-B/A-C training stage. If participants did not meet the criterion for combinatorial entailment a second time, they were dismissed from the study.

**Phase 3: Testing stimulus functions.** Following the conditional discrimination task, participants performed the approach and avoidance task (AAT). Participants were provided the instructions, “During the next phase of the study one image will be presented on the screen at a time. After viewing the image for a few seconds you will have the ability to modify the image. To pull the image closer to you press the ‘J’ key. To push the image away from you press the ‘F’ key. If you do not wish to change the image you can simply not press any key.” Stimuli were presented one at a time with the instructions “Press ‘F’ to make smaller, Press ‘J’ to make bigger.” Each trial began with a 2-second display where responding was not possible followed by a variable 5-10 second time window where responding was possible. The interval length was determined by a random number generator at the beginning of each trial. The variable length of the interval was designed to prevent a response strategy of tolerating potentially aversive images for a predictable short duration of time and also served to strengthen the ecological validity of the task, as the duration of aversive/appetitive stimuli is not always predictable in real world contexts.

 At the beginning of this phase participants were exposed to four practice trials accompanied by corrective feedback. During two of the practice trials participants were shown a stimulus that read “pull closer” and during the other trials they were shown a stimulus that read “push away.” Participants then performed 27 escape/approach trials with each of the 9 stimuli (A1, A2, A3, B1, B2, B3, C1, C2, and C3) presented three times each in random order.

**Analytic Strategy**

Study analyses were conducted using SPSS version 21. Prior to analysis the dataset was screened for univariate (*z* ≥ 3.29) and multivariate (Mahalanobis distance exceeding the critical value of 27.87 [*α* = .001]) outliers as well as normality. No outliers were identified and visual inspection of Q-Q plots across responding to the nine stimuli revealed no significant departures from normality.

Prior to testing study hypotheses, data reduction strategies were employed on the approach and escape task responses. The approach and escape responses were coded such that all approach responses were positive and all escape responses were negative. In each trial it was possible to engage in up to 10 approach responses (i.e., a score of 10) or 10 escape responses (i.e., a score of -10). Approach and escape composite scores for each of the nine study stimuli were generated (i.e., A1, A2, A3, B1, B2, B3, C1, C2, C3), with each composite score consisting of the sum of approach and escape responses across the three testing trials for the respective stimulus. Through this data reduction strategy, each participants’ approach and escape responses were considered in terms of 9 composite scores, varying along a continuum of -30 to 30. In this way, a positive score indicated a pattern of approach responses, a negative score indicated a pattern of escape responses, and a scores close to zero indicated undifferentiated or null responding.

Given that the psychological functions of the thinner and fatter stimuli were hypothesized to vary across participants, escape and approach responding to the untrained thinner (B1) and fatter (B3) body image stimuli were used to categorize study participants prior to analysis. Nine participants (26.5%) who made 10 or more approach responses to the thinner (B1) stimulus and 10 or more escape responses to the fatter (B3) stimulus were categorized as thinner appetitive (B1)/fatter aversive (B3). Eight participants (23.5%) who made 10 or more escape responses to the thinner (B1) stimulus and 10 or more approach responses to the fatter (B3) stimulus were coded as thinner aversive (B1)/fatter appetitive (B3). Seventeen participants (50%) displayed other patterns of responding, including escaping both thinner (B1) and fatter (B3; n = 3; 8.8%), approaching both thinner (B1) and fatter (B3; n = 5; 14.7%), and responding with less than 10 approach or escape responses to either or both stimuli (i.e. B1 and/or B3; n = 9; 26.5%). These participants were categorized as other responding. The 10 or greater response criterion for approach and escape categorization was selected prior to analysis as evidence of differentiated responding, as it required either full approach or escape responding during at least one trial or a consistent pattern of moderate levels of approach or escape responding across trials to meet the criterion (at least 3-4 responses per trial).

Data analysis proceeded in three phases. First, self-report measures of body image were scored according to published directions, and descriptive statistics calculated. Second, pearson product-moment correlations were calculated between participants approach and escape responses to the body image stimuli (B stimuli) and scores on established self-report measures of body image. The following analytic phases each directly addressed one of the two hypotheses. For the first hypothesis, participant responses in the conditional discrimination task were examined for evidence of mutual and combinatorial entailment in percentage of correct responses. As mentioned above, testing criterion was 16/18 trials (89%) for both testing stages. For the second hypothesis, participants’ approach and escape responses were examined for evidence of transformation of preexperimental functions of arbitrary stimuli consistent with the body image stimuli in the same stimulus class.

A mixed (between and within factor) MANOVA model was conducted to determine whether orderly patterns of responding to A and C stimuli emerged based on participant untrained responses to the thinner (B1) and fatter (B3) body image stimuli. Within-factor levels were specified as the three stimulus classes (i.e., “thinner,” “self,” and “fatter”) with mutually entailed (i.e., A1, A2, and A3) and combinatorially entailed relations (i.e., C1, C2, and C3) entered separately. The dependent variable (i.e., participants’ approach/escape composite scores for the A1, A2, A3, C1, C2, and C3 stimuli) were entered into the model as repeated measures, as we anticipated that each participant’s approach and escape responses to the stimuli would be correlated. The between-subjects factor (i.e. independent variable) was untrained response classification. That is, thinner appetitive (B1)/fatter aversive (B3; n = 9), thinner aversive (B1)/fatter appetitive (B3; n = 8), or other responding (n = 17).

Univariate repeated measure ANOVA models for mutually entailed (A) and combinatorially entailed (C) stimuli were used to follow up on a significant multivariate effects. A series of one-way ANOVA models comparing response clarifications across the three class members (i.e., “thinner”, “self”, and “fatter”) were used to follow up on significant univariate mutual or combinatorially entailed effects, with Tukey’s HSD used as a post-hoc technique to explore any significant one-way ANOVA models. In addition, visual analysis of participant level data was conducted for any mutually (A) or combinatorially entailed (C) stimuli with a significant group level effect.

**Results**

**Self-Reported Body Image Data**

Participant scores on self report measures are presented in Table 1, along with descriptive statistics. Correlational analyses revealed that higher levels of body image related psychological flexibility (BI-AAQ) was associated with greater escape of the thinner stimulus (B1) and greater approach of the fatter stimulus (B3). Conversely, higher levels of body image avoidance (BIAQ) was associated with greater approach of the thinner stimulus (B1) and greater escape of the fatter stimulus (B3). Finally, higher levels of body image quality of life (BIQLI) was associated with greater approach of the fatter stimulus (B3).

**Mutual and Combinatorial Entailment**

Participant responses in the conditional discrimination task were examined for evidence of mutual and combinatorial entailment. Thirty-two participants (94%) passed the test of mutual entailment and 31 participants (91%) passed the test of combinatorial entailment following class acquisition training. Of the three who did not pass combinatorial entailment, all achieved a passing score after exposure to a remedial block of mixed A-B/A-C training. Participant performance during class acquisition is presented in Table 2. The two participants who failed the test of mutual entailment (67% and 83% correct) passed the test of combinatorial entailment (100% and 94% correct, respectively). This pattern was unexpected, and procedures were not established a priori for handling such cases. These participants’ data were retained for analysis as they displayed robust evidence of combinatorial entailment, which is theoretically predicated on mutual entailment. These two participants did not receive remedial training as the program considered only their performance on combinatorial entailment when assigning remedial training blocks.

**Transformation of Function: Approach and Escape Responses**

During the four approach and escape practice trials, participants mostly emitted correct responses (*p̂ =* 95%) with four participants making one error (*p̂ =* 12%) and three participants once failing to respond (*p̂ =* 9%). Approach and escape responses from all 34 participants were retained for analysis as all emitted at least 75% correct responses during the practice trials.

 The interaction term of the primary mixed MANOVA model evaluating the relationship between untrained response classifications to thinner (B1) and fatter (B3) body image stimuli and responses to derived stimuli(i.e., “thinner,” self, and “fatter”) was significant, *V* = .68, *F*(8, 58) = 3.75, *p* = .001, partial *η2* = .341. Univariate follow-up analysis revealed that untrained response classifications predicted differential responding among stimulus classes (i.e., “thinner”, “self”, and “fatter”) for both mutually entailed stimuli (i.e., A stimuli), *F*(4, 62) = 9.43, *p* < .001, partial *η2* = .378, and combinatorially entailed stimuli (i.e., C stimuli), *F*(4, 62) = 9.75, *p* < .001, partial *η2* = .386.

**Mutual Entailment Follow-Up Analysis**. Follow-up one-way ANOVAs evaluating untrained response classification across the mutually entailed stimuli revealed a significant difference in responding to the thinner (A1), *F*(2, 31) = 10.98, *p* < .001, partial *η2* = .415, and fatter (A3), *F*(2, 31) = 8.97, *p* = .001, partial *η2* = .367, stimuli but not to the self (A2) stimulus. Participants who were classified as thinner appetitive (B1)/fatter aversive (B3) displayed significantly greater approach responses to the mutually entailed thinner (A1) stimulus (*M* = 18.89, SD= 21.23) relative to both thinner aversive (B1)/fatter appetitive (B3) participants (*M* = -16.88*, SD* = 14.05) and participants who were classified as other responding (*M* = -11.23, *SD* = 17.30). The converse effect was found for the fatter (A3) stimulus, with participations who were classified thinner aversive (B1)/fatter appetitive (B3) displaying significantly greater approach responses to the mutually entailed fatter (A3) stimulus (*M* = 16.50*, SD* = 16.95) relative to both thinner appetitive (B1)/fatter aversive (B3) participants (*M* = -19.56, *SD* = 11.21) and participants who were classified as other responding (*M* = -2.00, *SD* = 20.16). See Figure 2 for approach/escape composite means and standard errors across mutually entailed stimuli.

Participant level approach/response scores for the mutually entailed thinner stimulus (A1) and fatter stimulus (A3) are presented in Figures 3 and 4, respectively. Visual analysis of participant level approach/escape responses to the mutually entailed thinner stimulus (A1) revealed that 7 of the 9 (77.78%) participants classified as thinner appetitive (B1)/fatter aversive (B3) displayed a clear approach response pattern to the mutually entailed thinner stimulus (A1). The opposite response pattern was noted for participants classified as thinner aversive (B1)/fatter appetitive (B3), with 7 of the 8 (87.5%) displaying a pattern of escape responses to the mutually entailed thinner stimulus (A1). Visual analysis of responses to the mutually entailed fatter stimulus (A3) was also consistent with the effects reported in the group level analysis. All eight (100%) of the participants classified as thinner appetitive (B1)/fatter aversive (B3) escaped the mutually entailed fatter stimulus (A3), with 4 of 8 (50%) engaging in full escape responding (i.e., 10 escape responses during each exposure trial). In contrast, 7 of the 8 (87.5%) participants classified as thinner aversive (B1)/fatter appetitive (B3) displayed a pattern of approach responses to the mutually entailed fatter stimulus (A3).

**Combinatorial Entailment Follow-Up Analysis**. Follow-up one-way ANOVAs evaluating untrained response classification across the combinatorially entailed stimuli revealed a significant difference in responding to the thinner (C1), *F*(2, 31) = 5.77, *p* = .007, partial *η2* = .271, and fatter (C3), *F*(2, 31) = 13.47, *p* < .001, partial *η2* = .465, stimuli but not to the self (C2) stimulus. Participants classified as thinner appetitive (B1)/fatter aversive (B3) displayed significantly greater approach responses to the combinatorially entailed thinner (C1) stimulus (*M* = 13.56, SD= 18.93) relative to both thinner aversive (B1)/fatter appetitive (B3) participants (*M* = *-*15.63*, SD* = 16.00) and participants who were classified as other responding (*M* = -7.88, *SD* = 19.97). The converse effect was found for the fatter (C3) stimulus, with thinner aversive (B1)/fatter appetitive (B3) participants displaying significantly greater approach responses to the combinatorially entailed fatter (A3) stimulus (*M* = 23.50*, SD* = 11.98) relative to both participants classified as thinner appetitive (B1)/fatter aversive (B3; *M* = -18.67, *SD* = 19.03) and other responding (*M* = 2.41, *SD* = 17.28). See Figure 5 for approach/escape composite means and standard errors across combinatorially entailed stimuli.

Participant level approach/response scores for the combinatorially entailed thinner stimulus (C1) and fatter stimulus (C3) are presented in Figures 6 and 7, respectively. Visual analysis of responses to the combinatorially entailed thinner stimulus (C1) found that 6 of the 9 (66.67%) thinner appetitive (B1)/fatter aversive (B3) participants displayed an approach response pattern to the combinatorially entailed thinner stimulus (A1) while 6 of the 8 (75%) thinner aversive (B1)/fatter appetitive (B3) participants displayed an escape response pattern. The opposite effect was noted for the combinatorially entailed fatter stimulus (C3), with 8 of the 9 (88.89%) thinner appetitive (B1)/fatter aversive (B3) participants displaying an escape response pattern and 7 of the 8 (87.5 %) thinner aversive (B1)/fatter appetitive (B3) participants displaying an approach response pattern.

**Discussion**

The current study aimed to provide an initial examination of symbolic learning in the context of body image stimuli that might help elucidate a process by which people might come to approach or avoid seemingly neutral stimuli apparently unrelated to body image stimuli, as if they were actual body image stimuli themselves. Most participants derived equivalence relations between nonsense syllables and body images with ease. In addition, data supported transformation of function. In general, responses to participant-generated body image stimuli predicted the pattern of responses to the nonsense syllables. This is significant for several reasons.

First, researchers have appealed directly to RFT to conceptualize BDD (Neziroglu et al., 2004; Neziroglu et al., 2008b) and to justify continued developments of behavior therapy for BDD (Neziroglu, Khemlani-Patel, & Jacofsky, 2008a). There have been no empirical investigations, however, to support or inform this work. This study is the first to demonstrate DRR and transformation of aversive and appetitive body image functions to arbitrary stimuli. Further, entailment and transformation of function are posited, in RFT to be under contextual control (e.g., Perez, Fidalgo, Kovac, & Nico, 2015; Perez et al., 2017; Perkins, Dougher, & Greenway, 2007; Stewart, Barrett, McHugh, Barnes-Holmes, & O’Hora, 2013). This study offers one example of the kinds of contextual events that might foster transformation of body image functions to arbitrary stimuli, and thus creates a foundation for a program of research on (1) where the boundary conditions of such learning may lie, and (2) how we might limit the problematic effects of this learning.

Second, this study was the first to demonstrate the transformation of untrained aversive and appetitive functions through DRR in the context of body image. While careful experimental control has allowed experimenters to demonstrate the transformation of experimentally-established functions through DRR in a variety of studies (see Dymond & Rehfeldt, 2000), this study strengthens the literature on RFT by demonstrating the same with ecologically valid, idiographic functions of marked social significance. For RFT to continue to have an influence in the applied sector, contending with well-established, complex learning histories that vary across participants, is a must. For example, the next iteration of this study could examine the impact of extinction procedures on untrained and derived avoidance functions.

This study also contributes to the literature by examining the variability in transformation of untrained functions as an aspect of DRR. Despite clear evidence for DRR, the transformation of function data were not consistent across or within class relations. First, transformation of function was more robustly demonstrated across combinatorially entailed relations as compared with mutually entailed relations. Typically, however, this is described as a linear process, where mutually entailed relations are ‘combined’ to foster the derivation of combinatiorially entailed relations, and subsequent transformation of function. It may be, however, that treating DRR as a linear process is more an artifact of scientist’s efforts to conceptualize complex behavioral repertoires and create training procedures to examine their properties. It makes logical sense to imagine the combination of relations as a step that follows mutual entailment of relations, and this has allowed for development of conditional discrimination procedures like MTS that follow this linear pattern. However, to the extent that these “relations” are patterns of behavior, there is no reason to assume that they must emerge in a particular order. In fact, experimental preparations have demonstrated the decoupling of mutual from combinatorial entailment into distinct operants using reversal of reinforcement contingencies (e.g., Healy, Barnes-Holmes, & Smeets, 2000). In addition, a number of conceptual and methodological updates within RFT have included emphasis on nonlinear interplay between contextual and behavioral events (e.g., Barnes-Holmes, Barnes-Holmes, McEnteggart, 2020; Belisle & Dixon, 2020; Ninness, Ninness, Rumph, & Lawson, 2018).

It may also be that, for participants with extensive experience deriving relations with particular stimuli (e.g., female participants deriving relations with body image stimuli), patterns of derivation and transformation of function emerge more simultaneously. Facilitated acquisition of derived relations has been demonstrated with stimuli that are emotionally evocative and personally relevant (e.g., poorly performing students learning to relate arbitrary images to words like “flunk” or “dumb;” Adcock et al., 2011). It could be that increased levels of body image disturbance involves increased learning in relating events to aversive body images, and subsequently avoid them. Future research might directly examine facilitated acquisition amongst individuals with varying levels of BID in terms of independent emergence of mutual and combinatorial entailment with limited training.

Third, transformation of function was relatively weak across relations with the “self” body image stimulus, as compared to “thinner” and “fatter” stimuli. This was the first study that allowed participants to generate a unique image to represent the self in a conditional discrimination task. However, at least one study using self-referring words in a conditional discrimination task (e.g., “me,” “myself,” “I”; Merwin & Wilson, 2005) similarly reported limited success amongst participants, with nearly one-third failing the training. In other words, contextual cues that foster DRR with most stimuli may be insufficient when it comes to relations of coordination with self-referring stimuli. Future iterations of this study might investigate whether or not more explicit cues during stimulus generation would facilitate the acquisition of self-relevant stimulus functions. RFT posits a particular kind of DRR, *deictic relational responding*, which involves relations of discrimination of perspective (e.g., “I” and “you;” “here” and “there;” “now” and “then”; see McHugh & Stewart, 2012) that are thought to underlie the emergence of the self. For example, engaging in a brief task that involved using the “self” body image stimulus as an avatar might strengthen I, Here, and Now relations beyond the instructional control in this study [i.e., “Your task is to modify (if necessary) each of the part of the figure so that it conforms as far as possible to your real body image (“what I look like”)”] and thus foster transformation of function.

**Limitations and Future Directions**

 The conclusions that can be drawn from these data are limited by elements of the study’s design. For one, only female participants were recruited, leaving it uninvestigated how DRR mechanisms might be involved in body image for males. In addition, there was limited variability amongst recruited participants in terms of age and race. The study should be replicated with larger, more diverse samples. The study is also subject to the limitations involved in any group design. Ultimately, a more adequate behavioral analysis of DRR with body image would involve prediction and control of transformation of body image functions at the individual level. Future research might employ single case designs and focus on within-subject contextual manipulations that control transformation of values functions.

There are also limitations with regard to the stimuli used. For one, the nonsense syllables were not randomly assigned in the conditional discrimination task to various class memberships for each participant (e.g., NAK was the A1 stimulus for all participants). Thus, it is not possible to completely rule out responding based on the topographical properties of the nonsense words as a possible confounding source of stimulus control. Future research in this domain should randomize nonsense stimuli for each participant to attenuate this possible confound. There may also be conceptual problems with the use of textual stimuli for testing approach and escape functions. For example, in our study maximizing escape responses resulted in complete removal of the nonsense syllables, while maximizing approach responses simply made the stimulus larger. However, participants have likely learned to ignore certain dimensions (e.g., size, font, color) in discriminating responding to those stimuli. Future research should replicate these findings with non-textual stimuli.

Another limitation relates to the body image stimuli captured from the BIAS. While they were designed to be realistic in shape and proportion, they were computer-generated drawings and may have had limited impact. Although figural line drawings are commonly used in the assessment of body image dissatisfaction, several threats to validity have been noted (e.g., Brown & Gardner, 2010). Future research might seek to replicate these findings with photographs (e.g., Swami, Salem, Furnham, & Tovée, 2008), perhaps with morphing capabilities (Stewart, Williamson, Smeets, & Greenway, 2001). In addition, the BIAS images pictured short, brown hair, brown eyes, and tan skin, making them potentially difficult for participants to relate to if they had long hair or light coloring. Several researchers (e.g., Altabe, 1996; Thompson, 1996) have suggested that these details should be omitted from such assessments. For tasks like in the current study, however, the most evocative image would be most useful. Future research on DRR with body image might employ digitized images of participants’ own bodies (e.g., Gardner & Brown, 2010) or allow participants to manipulate other physical characteristics like hair, skin, or even clothing.

In addition to concerns regarding stimuli, some participants made errors during practice trials approach and escape task trials. These participants may not have fully understood the task and could have introduced additional variance into the obtained findings. Future research should employ additional practice trials and require accurate responding during practice to ensure that all participants fully understand the task. In addition, the approach and escape task was designed such that participants could not change the direction of their response during the same trial. If they began a trial by pressing ‘J’ to make the image bigger, the ‘F’ button was not functional until the next trial. This may have limitations as a proxy for real life approach and escape, where people can always move closer to or further from something regardless of their previous actions. Future use of this task might allow for approach and escape responses to be emitted within trials. Additional tests of transformation of function could also be incorporated, including semantic differential tasks (Bortoloti & de Rose, 2009) or the Implicit Relational Assessment Procedure (Gomes et al., 2019).

Future researchers could look to expand upon this current work by placing it in context with analog RFT research that suggests that an avoidance response that is highly generalized may be most quickly and effectively extinguished if exposure is applied to events related to the feared event rather than to the event itself (Roche et al., 2008; see also Dymond, Bennett, Boyle, Roche, & Schlund, 2018). Applying these RFT analog findings to treatment of BID could have important implications for treatment, in that behavioral treatments of body image might be most effective at impacting body image avoidance by including exposure to events that have come to elicit distress through their relations with the body (e.g., an invitation to a sleepover).

Despite limitations, the data support ongoing investigations into DRR with body image. As purported in theoretical accounts of how BID is learned (e.g., Neziroglu et al., 2008; Neziroglu, et al., 2004), people can, in fact, learn easily to escape relatively neutral events in their lives because they have learned to relate those events to body image via symbolic pathways (i.e., via DRR). The next steps are to further investigate the contexts that impact this process, which would have direct implications for prevention and treatment of BID.

Open Practices Statement: None of the data or materials for the experiments reported here is publicly available, and none of the experiments was preregistered.

Research Data Availability: Data are available upon request from the corresponding author.

C**ompliance with Ethical Standards**

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* All methods were approved by the Institutional Review Board at the University of Louisiana at Lafayette
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Table 1. Self-Reported Body Image Flexibility (BI-AAQ), Body Image Avoidance (BIAQ),

and Body Image Quality of Life (BIQLI), and Correlations with Approach/Escape Responses to B Stimuli

|  |  |  |  |
| --- | --- | --- | --- |
| Participant | BI-AAQ | BIAQ | BIQLI |
| 1 | 60.00 | 32.00 | -0.37 |
| 2 | 62.00 | 21.00 | 0.95 |
| 3 | 45.00 | 32.00 | -0.84 |
| 4 | 75.00 | 18.00 | 0.84 |
| 5 | 48.00 | 25.00 | 0.89 |
| 6 | 55.00 | 32.00 | -0.26 |
| 7 | 80.00 | 24.00 | 1.79 |
| 8 | 16.00 | 63.00 | -1.47 |
| 9 | 32.00 | 40.00 | -0.79 |
| 10 | 65.00 | 44.00 | 1.74 |
| 11 | 69.00 | 24.00 | 0.00 |
| 12 | 63.00 | 31.00 | 0.63 |
| 13 | 83.00 | 12.00 | 2.74 |
| 14 | 57.00 | 34.00 | 2.11 |
| 15 | 54.00 | 20.00 | 0.26 |
| 16 | 84.00 | 13.00 | 3.00 |
| 17 | 48.00 | 49.00 | 1.42 |
| 18 | 80.00 | 21.00 | 0.47 |
| 19 | 60.00 | 26.00 | 1.74 |
| 20 | 44.00 | 26.00 | 0.21 |
| 21 | 70.00 | 30.00 | 1.21 |
| 22 | 62.00 | 22.00 | 1.53 |
| 23 | 51.00 | 32.00 | 0.89 |
| 24 | 50.00 | 23.00 | 0.74 |
| 25 | 35.00 | 16.00 | 1.63 |
| 26 | 39.00 | 29.00 | 1.74 |
| 27 | 25.00 | 58.00 | -2.26 |
| 28 | 71.00 | 33.00 | 0.32 |
| 29 | 79.00 | 23.00 | 2.47 |
| 30 | 47.00 | 33.00 | -0.95 |
| 31 | 36.00 | 41.00 | -0.26 |
| 32 | 71.00 | 29.00 | 0.63 |
| 33 | 40.00 | 51.00 | -1.26 |
| 34 | 32.00 | 32.00 | 1.89 |
| *M* | 55.53 | 30.56 | 0.69 |
| *SD* | 17.61 | 11.86 | 1.25 |
| *Range* | 16 – 84 | 12 – 63 | -2.26 – 3.00 |
| *r*B1*r*B2*r*B3 | -.35.11.40 | .43-.14-.61 | -.22-.09.41 |

Table 2. *Descriptive Statistics of Class Acquisition Performance*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Mean | SD | Median | Min | Max |
| Trial Blocks to Criterion Train A-B Train A-C Mixed Train A-B/A-C Total | 2.941.911.246.09 | 1.250.750.611.60 | 3216 | 1114 | 6439 |
| Training Time (minutes) | 12:30 | 3:26 | 12:17 | 7:53 | 20:07 |
| Testing Accuracy (% correct) Mutual Entailment Combinatorial Entailment | 96.2698.12 | 6.563.36 | 100100 | 6789 | 100100 |

*Note.* Trial blocks to criterion were calculated for each participant by summing the number of times they were sequenced through the training block before meeting the pass criterion (≥89%). Data from the second testing blocks were used for participants who received remedial mixed training.

|  |  |
| --- | --- |
|  | Relational Classes |
|  | 1 | 2 | 3 |
| A Stimuli |  |  |  |
| BStimuli |  |  |  |
| CStimuli |  |  |  |

*Figure 1.* Study Stimuli. B stimuli were uniquely generated for each participant based on their responses in the BIAS program, with the magnitude of change of the B1 (thinner) and B3 stimuli (fatter) stimuli relative to the B2 (self) stimuli held constant across participants.

*Figure 2*. Mean composite scores of approach (positively scored) and escape (negatively scored) responses to mutually entailed stimuli (A stimuli) by response classification. Error bars depict standard error of the mean.

*Figure 3*. Participant-level composite scores of approach (positively scored) and escape (negatively scored) responses to the mutually entailed thinner stimulus (A1) by response classification.

*Figure 4.* Participant-level composite scores of approach (positively scored) and escape (negatively scored) responses to the mutually entailed fatter stimulus (A3) by response classification.

*Figure 5.* Mean composite scores of approach (positively scored) and escape (negatively scored) responses to combinatorially entailed stimuli (C stimuli) by response classification). Error bars depict standard error of the mean

*Figure 6.* Participant-level composite scores of approach (positively scored) and escape (negatively scored) responses to the combinatorially entailed thinner stimulus (C1) by response classification.

*Figure 7.* Participant-level composite scores of approach (positively scored) and escape (negatively scored) responses to the combinatorially entailed fatter stimulus (C3) by response classification.