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DERIVED TRANSFORMATION OF CHILDREN'S PREGAMBLING GAME PLAYING

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Contemporary behavior-analytic perspectives on gambling emphasize the impact of verbal relations, or derived relational responding and the transformation of stimulus functions, on the initiation and maintenance of gambling. Approached in this way, it is possible to undertake experimental analysis of the role of verbal/mediational variables in gambling behavior. The present study therefore sought to demonstrate the ways new stimuli could come to have functions relevant to gambling without those functions being trained directly. Following a successful derived-equivalence-relations test, a simulated board game established high- and low-roll functions for two concurrently presented dice labelled with members of the derived relations. During the test for derived transformation, children were reexposed to the board game with dice labelled with indirectly related stimuli. All participants except 1 who passed the equivalence relations test selected the die that was indirectly related to the trained high-roll die more often than the die that was indirectly related to low-roll die, despite the absence of differential outcomes. All participants except 3 also gave the derived high-roll die higher liking ratings than the derived low-roll die. The implications of the findings for behavior-analytic research on gambling and the development of verbally-based interventions for disordered gambling are discussed.
Key words: gambling, equivalence relations, transformation of functions, children

Approximately 1% of children, adolescents and young adults in the United Kingdom between the ages of 16 and 24 years (Wardle et al., 2007), and 11.2%, with a range of 7.7% to 34.9%, of youth and adolescents in the United States (National Research Council, 1999) meet the criteria for pathological gambling. Increases in the prevalence of adolescent gambling are of concern because those who begin gambling at a young age are more likely not only to later develop pathological gambling (Burge, Pietrzak, & Petry, 2006; Hurt, Giannetta, Brodsky, Shera, & Romer, 2008; Knapp & Crossman, 2006), but are also at greater risk for behavior disorders, including conduct disorder and substance abuse (Burge et al., 2006; Wanner, Vitaro, Carbonneau, & Tremblay, 2009; Welte, Barnes, Tidwell, & Hoffman, 2008, 2009).

Researchers have emphasized the central role of cognitive and affective variables such as a positive affect toward gambling (Hurt et al., 2008), impulsivity (Pagani, Derevensky, & Japel, 2009), and beliefs and perceptions about the nature of gambling in gambling initiation by children and adolescents (Delfabbro, Lahn, & Grabosky, 2006; Delfabbro, Lambos, King, & Puglies, 2009; Derevensky, Gupta, & Baboushkin, 2007). Delfabbro et al. (2006, 2009), for example, found that adolescent gamblers had a poor understanding of the nature of probabilities, randomness and games of chance, and considered gambling to be a potentially profitable activity. Findings like these are generally interpreted in mediational terms such as the ''cognitive switching'' account of Sevigny and Ladouceur (2003), which describes how gamblers, when confronted with gambling-related information, often report having little control over the outcomes of chance events, yet ''nonetheless act in a way that indicates the presence of erroneous beliefs'' (Delfabbro et al., 2009, p. 534).

A limitation of mediational explanations is that they tend to treat mediational ''responses'' (e.g., self-stated rules, beliefs, etc.) as primary causes. Individual differences with

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regard to mediational responses is purported to explain observed differences in gambling situations. Unfortunately, such an approach places the causes of gambling in the thoughts and other behaviors of the participants, and we are left unable to determine the conditions that cause those thoughts. Information about the mediational variables is important in that they allow us to predict gambling. However, they do not allow us to control the occurrence of gambling. A behavior-analytic perspective on the same problem does not eschew consideration of mediational variables but rather focuses on the environmental contexts that give rise to different mediational responses (Hayes & Brownstein, 1986). This perspective allows for both prediction and control and potentially places gambling behavior within the purview of an experimental analysis (Weatherly & Dixon, 2007).

Two recent research examples illustrate the promise of this approach. First, a study by Johnson and Dixon (2009) shows how an experimental history can lead to gambling behavior that appears to indicate ''the presence of erroneous beliefs'' and override programmed reinforcement contingencies. Children, aged 7 to 10 years, played a simulated board game in which they could choose, on each turn, either of two concurrently presented dice that differed only by color (one red, one blue). Each die was programmed to roll a random number between 1 and 6, and each child's preselected game piece then moved the corresponding number of spaces along the on-screen racetrack. Next, in a conditional discrimination procedure, the two colors (blue and red) were trained as contextual cues for more-than and less-than nonarbitrary relational responding, respectively (see Hoon, Dymond, Jackson & Dixon, 2008; Zlomke & Dixon, 2006). For instance, participants were presented with two comparison stimuli of differing physical quantities, such as three slices of pizza and six slices of pizza, and reinforcement delivered for selecting the three slices in the presence of the contextual cue for less-than (i.e., background color of blue), and for selecting the six slices in the presence of the contextual cue for more-than (i.e., background color of red). Then the children played the simulated board game again. Although the contingencies governing dice rolling were unchanged, all but one child showed increased use of the die whose color served as the more-than contextual cue (red). In the language of stimulus relations, these results show how, through relational experience, contingency-irrelevant features of a game of chance can come under nonarbitrary contextual control by formal features (such as dice colors). In lay terms, the children behaved as if they believed one die to be ''hot'' or ''lucky,'' even when the outcomes of their rolls indicated otherwise.

Johnson and Dixon (2009) did not measure verbal behavior, but other studies have focused on verbal relations in gambling behavior. According to prevailing behavior-analytic accounts, a verbal stimulus acquires its functions based, at least in part, on participation in a derived relation or relational frame (Barnes-Holmes, Hayes, Dymond, & O'Hora, 2001; Dixon & Delaney, 2006; Dymond, 2008; Dymond & Rehfeldt, 2000; Dymond & Whelan, 2007). For instance, the impact of derived relational responding on gambling behavior has been studied by Dixon, Nastally, Jackson and Habib (2009) who showed that derived equivalence relations could alter recreational gamblers' ratings of slot machine outcomes. During a pretest phase, Dixon et al. presented participants with three graphic displays of slot machine outcomes depicting a win (i.e., three matching symbols on a payout line), a near miss (i.e., two matching symbols and one different symbol on a payout line) and a loss (i.e., three different symbols on a payout line; C1, C2 and C3, respectively), and asked them to rate how close the image was to a win. Next, participants were trained in the formation of A–B and A–C conditional discriminations, before being tested once for symmetry (B–A and C–A) and equivalence relations (B–C and C–B). The A1, A2, and A3 stimuli consisted of three abstract images, and the B1, B2, and B3 stimuli consisted of the text ''win'', ''loss'' and ''almost'', respectively. Finally, in the posttest phase participants were presented again with the C1, C2 and C3 stimuli. Dixon et al. predicted that if derived equivalence relations were formed between the B–C and C–B stimuli, then the B3 stimulus (''almost'') should acquire some of the functions of the C3 loss image and the B2 stimulus (''loss'') should acquire some of the functions of the C2 near-miss image (the B1 stimulus, ''win'', should remain unchanged as it was related via equivalence to the C1 win image, and vice versa). Results indicated that, relative to pretest levels, the majority of participants rated the C3 ''loss'' stimulus as closer to a win than the C2 ''near miss'' stimulus. Moreover, when the requisite derived relations were not formed, the predicted performances failed to emerge. These findings demonstrate how intra-experimentally established derived verbal relations may influence recreational gamblers' ratings of slot machine outcomes in ways that may override the contingency-relevant functions of gambling stimuli. In effect, the gamblers behaved as if the three different symbols on the payout line were closer to a win than the ''almost winning'' near miss display of two matching symbols (Habib & Dixon, 2010; Reid, 1986).

The present study sought to further investigate the impact of verbal relations on gambling behavior by examining whether or not a key defining feature of derived relational responding—the transformation of stimulus functions—occurs during analogue gambling tasks with young children. Transformation of stimulus functions is said to occur when the psychological functions of stimuli in a derived relation are transformed based on the nature of the relation and the psychological functions of the other member(s) of that relation. For example, if A is related to B and B is related to C, and C is paired with a winning slot machine outcome that evokes arousal and approach functions, then presentations of A will also likely evoke similar conditioned arousal and approach functions by virtue of the derived C–A equivalence relation (for a review, see Dymond & Rehfeldt, 2000). Transformation of stimulus functions may partly explain the emergence of gambling behavior, such as an increased preference for a novel slot machine, that arises in the absence of a direct learning history and may, ostensibly, appear to indicate control over behavior by ''erroneous beliefs''. To date, however, no previous study has shown whether gambling relevant response functions may be shown to transform in accordance with derived equivalence relations. Such a demonstration would greatly extend the potential utility of behavioral models of gambling in explaining the emergence and maintenance of gambling behavior in the absence of direct reinforcement and contribute towards potential verbally-based interventions to overcome disordered gambling (Petry, 2009). Undertaking this analysis with young children's pregambling game playing is important in developing an empirical account of verbal mediation effects in terms of transformation of function and how it may lead to disordered gambling.

The present study sought to extend Johnson and Dixon's (2009) findings by showing that children's pregambling responses may be altered via derived relational responding and the transformation of functions. Following tests for the formation of derived equivalence relations (A1–B1–C1 and A2–B2–C2), an adapted version of Johnson and Dixon's simulated board game was used to attach high- and low-roll functions to two dice labelled B1 and B2, before testing for transformation of functions with presentations of dice labelled C1 and C2.

METHOD

Participants and Setting

Twelve typically developing children between 8 and 10 years of age and balanced by gender were recruited from a local primary school in the United Kingdom. The children were recruited through letters and consent forms circulated to all parents of children in the school's junior classes. Of the 30 consent forms returned to the school, 12 were randomly selected to participate and signed parental consent was obtained prior to commencing the study. Children were compensated with £0.01 per point they earned during the study.

Sessions were conducted in a quiet, unused computer lab in the children's school. A laptop computer with a 38-cm screen and external mouse, programmed in Visual Basic.NET, controlled stimulus presentations and recorded all responses. The stimuli consisted of six nonsense syllables (BEH, ZID, PAF, MAU, VEK and ROG), which were randomly assigned to two stimulus sets. To ensure children could read the stimuli, prior to the first session each participant was asked to read aloud each of the six stimuli on individual flashcards. No errors were observed. Throughout all phases, the computer recorded all trial-by-trial dependent variables in Microsoft® Excel and .txt formats.

Procedure

Prior to the first session, the researcher escorted each child to the computer lab and

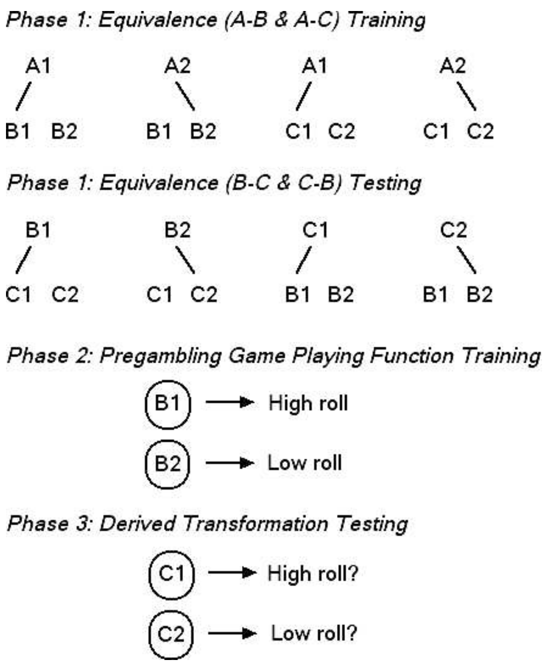

Fig. 1. Overview of the experimental procedure. Solid lines indicate trained and test relations (see text for details).

briefly informed them that they would be playing two different computer games, that they could ask questions at any time, take a break whenever they wanted, and withdraw from the study at any time. On indicating their understanding of these points, the study commenced. The study phases and sequence are depicted in Figure 1.

Phase 1: Equivalence training and testing. The purpose of this phase was to train a series of conditional discriminations and then test for the formation of two 3-member equivalence relations (A1–B1–C1 and A2–B2–C2). Prior to commencing this phase, the researcher read aloud the following instructions displayed on the computer screen:

> In a moment some words will appear on the screen. Look at the words at the top of the screen, and then look at the two words at the bottom of the screen, on the left and right. Choose one of two words from the words at the bottom of the screen by clicking on it. Sometimes the computer will give you feedback, and at other times it will not. However, you can get all of the tasks without feedback correct. Do you have any questions?

After reading the instructions, the researcher answered any questions by referring to the relevant part of the instructions. A delayed matching-to-sample procedure was used to train the conditional discriminations. Each trial started with a blank, white screen followed 1000 ms later by a sample stimulus displayed in the center, upper portion of the screen. The sample remained onscreen for 2000 ms before it was removed and, after 500 ms, the two comparisons appeared in the left and right corners of the lower portion of the screen. The comparisons remained onscreen until a response occurred by clicking on one with the computer mouse.

During conditional discrimination training, a one-to-many structure was employed. That is, selections of B1 given A1, B2 given A2, C1 given A1 and C2 given A2 were reinforced, with each trial type presented twice in a block of eight trials (Figure 1). Participants had to make eight consecutively correct responses in a block to meet the training criterion.

On meeting this criterion, probes for combined symmetry and transitivity (i.e., B–C and C–B) were presented, in the absence of feedback. It was predicted that participants would select B1 given C1, B2 given C2, C1 given B1 and C2 given B2 (Figure 1). Each of these four trial types (B1–C1, B2–C2, C1–B1 and C2–B2) was presented four times in a block of 16 trials. A predetermined mastery criterion of a minimum of 14/16 (87.5%) correct responses was employed. If this criterion was not met, participants were reexposed to conditional discrimination training and equivalence testing for a maximum of four further exposures. This predetermined mastery criterion helped ensure that the predicted performances were largely derived from the trained relations, not by the additional feedback provided by repeated training and testing, and minimized the extraneous sources of stimulus control often found in two-choice matching-to-sample procedures (see Boelens, 2002; Carrigan & Sidman, 1992).

Phase 2: Pregambling game functions training. The purpose of this phase was to expose participants to a simulated board game adapted from Johnson and Dixon (2009) that involved two concurrently presented dice, race vehicles and a serpentine track. The dice were labeled with the nonsense syllables corresponding to B1 and B2 and were programmed

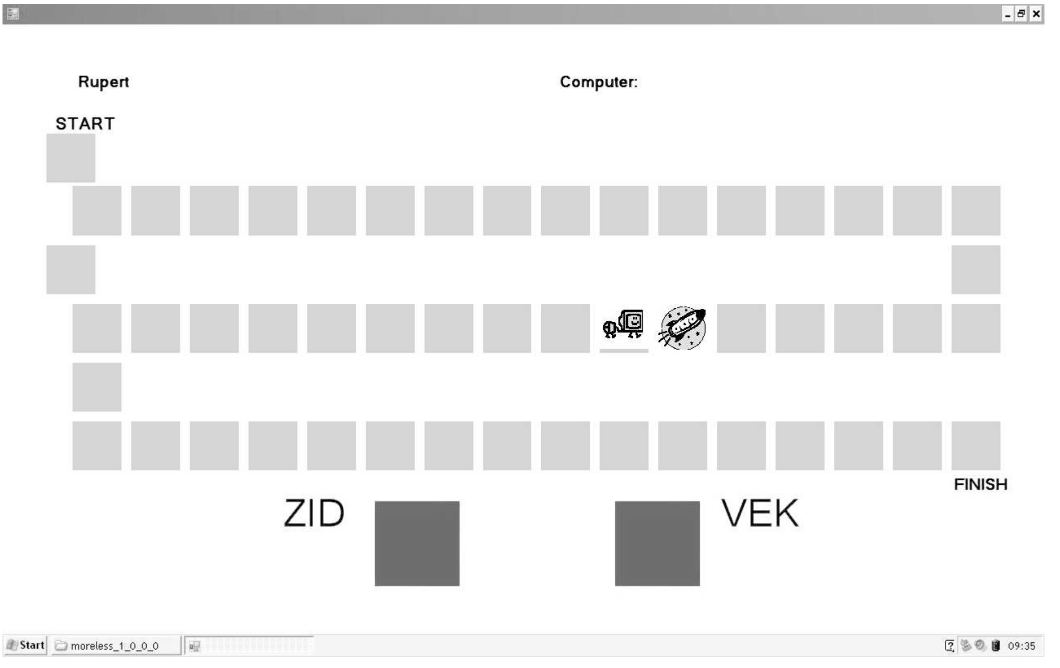

Fig. 2. Screenshot of the simulated board game used during Phases 2 and 3. The screen shows a serpentine racetrack consisting of 50 squares from start to finish, two dice labeled B1 and B2, the child's preselected game piece (a rocket), the computer game piece, and space for both the child's and the computer's scores to be accumulated in the top right and left hand corner, respectively. See text for further details.

via computer software to roll high and low range numbers, respectively (Figure 1). Phase 2 began when the researcher read aloud the following instructions (adapted from Johnson and Dixon, p. 75), which were displayed on the computer screen:

> Now, you are going to play a game where you are racing against the computer. First, you will select what you want your game piece to look like. Then you will see a racetrack with your chosen piece and the computer. In order to move your piece, you need to click on either square at the bottom of the screen to roll the dice; the dice will be labeled [nonsense syllable corresponding to B1] and [nonsense syllable corresponding to B2]. Your piece will move according to what you roll. If your car reaches the finish line first you will get a medal. Each medal is worth 1 sticker so try and get to the finish line before the computer does as many times as you can!

After listening to the instructions, participants selected a game piece from one of the five available (a car, a girl, a rocket, a tank or a unicorn) and, in order to increase the salience of the game, the participant's name appeared onscreen adjacent to their chosen piece.

Figure 2 shows a screenshot of the simulated board game during this phase. The purpose of the simulated board game was to establish a baseline of responding between the two concurrently available dice labeled B1 (''more-than'') and B2 (''less-than''). The dice randomly appeared in either the left or the right position to avoid any position bias and were programmed so that only one could be clicked on any given occasion. A trial began with an observing response of clicking an additional button labeled ''click to roll'' that appeared on the screen instead of the two dice prior to each roll. The two dice were programmed to roll either high- or low-range numbers: the die labeled B1 (''more-than'') was programmed to always roll high-range numbers (i.e., 4, 5 and 6) and the die labeled B2 (''less-than'') was programmed to roll low-range numbers (i.e., 1, 2 and 3). Once selected, the dice approximated a spinning motion with accompanying auditory feedback before stopping on a number within the programmed range. The participant's selected game piece then moved the rolled number of spaces along the track, followed by the computer game piece for a predetermined number of spaces. Each time a participant's game piece beat the computer and ''won the race'' a positive sound (''ta da'' from the Windows sound files) was played.

Participants had ongoing visual access to their accumulating scores (number of medals won) displayed at the top of the screen throughout this phase. Each medal was equivalent to 25 points or 1 sticker, and participants won a medal every time they beat the computer (i.e., their game piece completed the track before the computer), which involved a game piece moving a total of 50 spaces. Phase 2 consisted of a minimum of 20 trials (i.e., 20 selections of either B1 ''more-than'' or B2 ''less-than''). In order to demonstrate a clear response preference, participants were required to select the B1 (''more-than'') die on at least 80% of trials. The computer program automatically recorded when a game piece completed the racetrack and determined whether or not the criteria were achieved. If either the participant or the computer completed the racetrack prior to the predetermined minimum number of trials, a new racetrack appeared onscreen and the program continued until the criteria were met. If the criteria were not met, the program presented additional trials necessary to complete the current racetrack.

When the criteria were met, participants were required to rate how much they liked each of the dice using a five-point Likert rating scale (where 1 = *Don't like*, 2 = *Sort of don't like*, 3 = *Don't like or dislike*, 4 = *Sort of like*, and 5 = *Like it a lot*). Participants were asked, ''Using the rating scale, can you tell me how much you like the dice called B1 and B2?'' Ratings were made by clicking one of the numbers displayed on the slider scale, which was displayed onscreen immediately below the question.

Phase 3: Test for derived transformation of pregambling game playing functions. The purpose of this phase was to test whether participants would choose the die labeled C1 more often that the die labeled C2 by virtue of the derived relation with the directly trained functions attached to B1 and B2 in Phase 2 (Figure 1). Phase 3 began when the researcher read aloud the following instructions displayed on the computer screen:

> Now that you have learned to play the game you will have a chance to play it again. Like before, you will first select what you want your game piece to look like. Then, you will see a racetrack with your chosen piece and the computer piece. In order to move your piece, you need to click on either square at the bottom of the screen to roll the dice. The dice will be labeled [nonsense syllable corresponding to C1] and [nonsense syllable corresponding to C2]. Can you remember seeing these names before? This time, you will not be able to see what you roll, but the computer will store all the information and the researcher will tell you at the end. Your task is to try and reach the finish line as many times as you can and win the game before the computer! Let the researcher know if you have any questions.

As before, participants selected a game piece, followed by the observing response and then one of the two concurrently presented dice labeled C1 and C2, respectively. In Phase 3, all other aspects of the simulated board game were identical to those of Phase 2, except for the following important differences. First, the consequences of each die selection (i.e., the number of spaces each game piece moved after the dice roll) were matched: each trial ended with the participant's game piece completing the racetrack, regardless of the die selected. This was necessary in order to test for derived transformation of the directly trained functions of B1 (''more-than'') and B2 (''less-than'') in accordance with equivalence relations to C1 and C2. Second, this phase consisted of only 10 trials.

Following the 10th and final trial, participants were asked to rate how much they liked the C1 and C2 dice using the five-point Likert rating scale. The researcher then informed participants of how many points they had earned, provided the appropriate number of stickers and money, and thanked them for their participation.

RESULTS

Phase 1: Equivalence Training and Testing

Table 1 shows the number of training trials to criterion and the number of correct test trials per exposure for each participant in Phase 1. Participants 6, 9, 11 and 12 failed to reach the criterion of a minimum of 14 out of 16 correct responses (87.5%) on the equivalence test

Table 1

Phase 1: Conditional discrimination training trials to criterion and equivalence relations test trials correct per exposure for each participant.

Participant	Number of A–B & A–C training trials to criterion	Number of B–C & C–B test trials correct (minimum 14/16)
1	209	8
	18	7
	13	4
	19	15
2	60	15
3	101	15
4	160	9
	15	13
	8	15
5	25	15
6*	56	7
	12	9
	11	11
	11	8
	53	13
7	100	10
	21	14
8	43	9
	54	15
9*	57	10
	8	10
	12	13
	8	11
	8	12
10	97	15
11*	236	12
	8	13
	8	10
	17	10
	9	13
12*	91	9
	14	8
	8	11
	13	12
	17	10

Note. * denotes participants who failed to achieve criterion within the predetermined four test exposures.

within five exposures and were excused from further participation. Of the remaining 8 participants, 4 passed the equivalence test on their first exposure, 2 on their second, 1 on his third, and 1 on his fourth exposure. Participants who passed the equivalence test required a mean of 62.87 trials (range, 8 to 209) to reach the training criterion.

Phase 2: Pregambling Game-Playing Function Training

All participants met the training criterion within a mean of 21.75 trials (range 20 to 24). Figure 3 (upper panel) shows that, as predicted, participants selected B1 (M = 89.8%; range 82% to 95%) significantly more frequently than B2 (M = 10.1%; range, 5% to 18%), $t(7) = 20.78$, $p < .01$. The lower panel of Figure 3 shows all participants gave B1 the highest possible liking ratings and that, except for Participants 8 and 10, also gave B2 low liking ratings. Overall, participants rated B1 significantly higher than B2, Wilcoxon $T = -2.549$, $p = .011$.

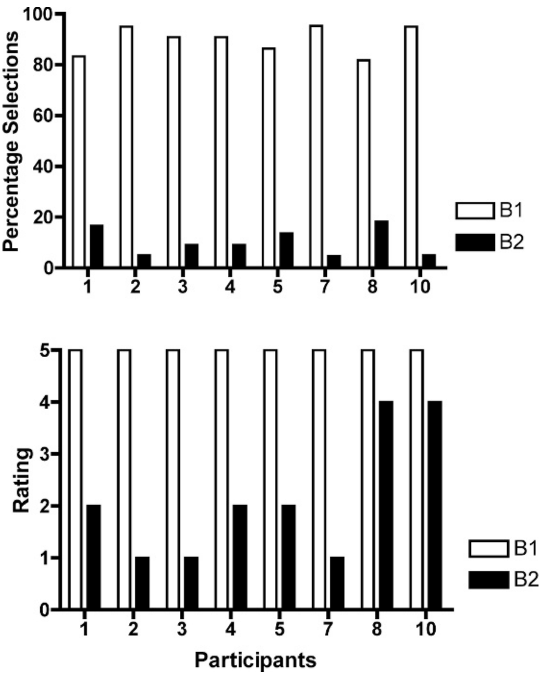

Fig. 3. Percentage of selections (upper panel) and liking ratings (lower panel) for the B1 and B2 dice during Phase 2.

Phase 3: Test for Derived Transformation of Pregambling Game-Playing Functions

Figure 4 (upper panel) shows that all participants, except Participant 10, selected C1 more often than C2 during the derived transformation test phase. Participant 10 selected C1 on 30% of trials and also gave equal liking ratings to C1 and C2 (see Figure 4, lower panel). Participant 2 and Participant 4 both gave equal liking ratings to the two stimuli, despite showing a clear preference for C1 over C2. A similar finding was observed with Participant 7 who only selected C2 on 10% of trials yet gave it a liking rating of 4.

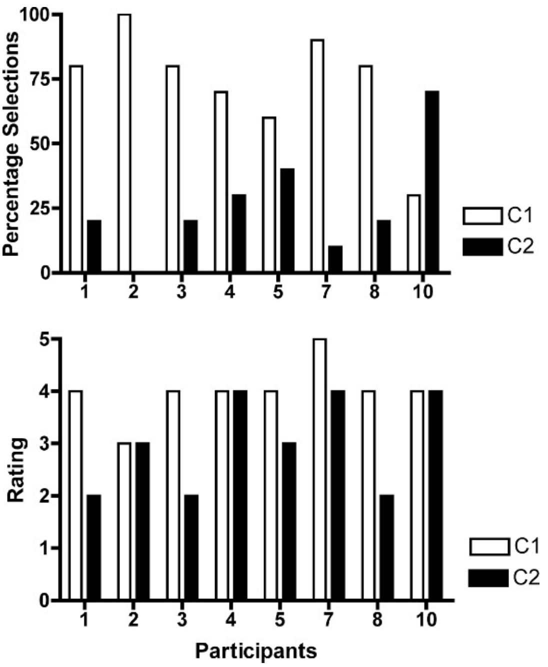

Fig. 4. Percentage of selections (upper panel) and liking ratings (lower panel) for the C1 and C2 dice during Phase 3.

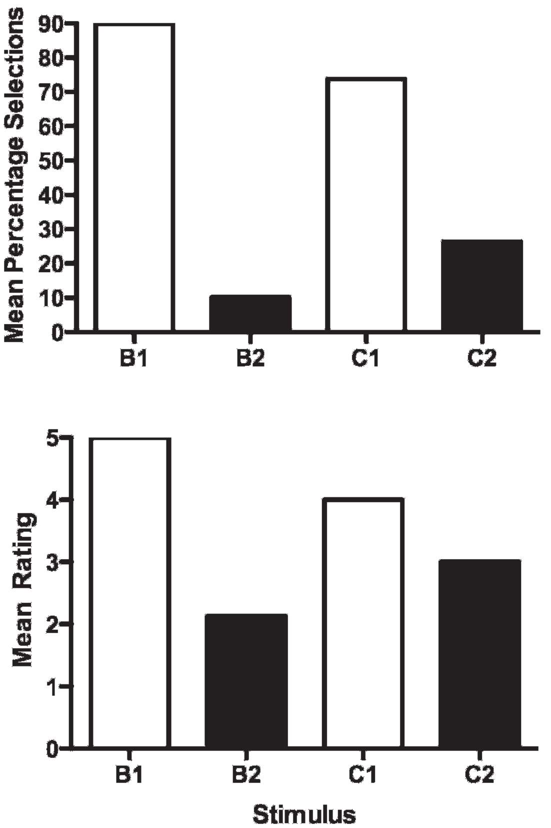

Fig. 5. Mean percentage of selections (upper panel) and mean liking ratings (lower panel) for the B1, B2, C1 and C2 dice during Phase 2 and Phase 3, respectively.

Figure 5 shows the mean percentage of selections and the mean ratings of the directly trained B1 and B2 stimuli and the derived C1 and C2 stimuli. Overall, participants selected C1 (M = 73.7%; range 30% to 100%) significantly more often than C2 (M = 26.2; range 0% to 70%), $t(7) = 3.148$, $p < .02$, and rated C1 significantly higher than C2, Wilcoxon $T = -2.070$, $p = .038$.

DISCUSSION

The findings of the present study extend those of Johnson and Dixon (2009) specifically, and the wider literature on derived relational responding more generally, by demonstrating for the first time a transformation of children's pregambling game- playing functions in accordance with equivalence relations. All except 1 of the participants who passed the equivalence relations test selected the C1 die more often than the C2 die, despite the absence of differential feedback following each dice roll, and all except 3 gave C1 higher liking ratings than C2. The increased response allocation and liking ratings for C1 relative to C2 suggests that the directly trained functions of B1 and B2 were transformed in accordance with the derived equivalence relations between the B and C stimuli.

Participant 10, who failed to demonstrate the predicted performance, passed the equivalence test on the first exposure, and it is possible that he would have subsequently met the derived transformation test criteria with further test exposures. This possibility would have been further strengthened had the present study adopted similar predetermined mastery criteria for both the transformation of functions and the equivalence relations test phases. Although it is recommended to employ predetermined exposure criteria during transformation of functions testing (Dymond & Rehfeldt, 2000), it is possible that, in the present study, the lack of differential consequences during any repeated exposures to the C1 and C2 dice would have influenced subsequent test performance. Further research on this possibility, and in developing novel procedures to test for transformation of gambling-relevant stimulus functions in children, is warranted.

In addition to measuring participants' response selections of C1 and C2, the present study obtained a supplemental measure of derived transformation by recording self-reported liking ratings of each stimulus following the simulated board game. Our findings revealed some consistency between the measures, with the majority of participants demonstrating both increased selections and higher liking ratings for C1 over C2. The only participant who did not select C1 more often than C2 (i.e., Participant 10), was also 1 of the 3 participants who gave the stimuli equal liking ratings during the transformation of functions test phase. The present findings, therefore, are in line with those of previous studies that have included self-report ratings-based measures of derived transformation (e.g., Dixon et al., 2009; Smyth, Barnes-Holmes, & Forsyth, 2006). The present study has some limitations. First, 4 of the 12 participants that started the study failed to reach criterion on the equivalence test within the predetermined five exposures and were excused from further participation. The combined stability and exposure criteria, however, allowed equivalence test performances other than those predicted to emerge. That is, participants could respond in a manner that was consistent, but not necessarily correct. Participants that responded in this manner were not exposed to the simulated board game phases and tests for derived transformation because previous research indicates that the predicted performances are unlikely to emerge when the requisite derived relations have not been established (Dymond & Rehfeldt, 2000). This remains an empirical question because other studies have found that participants who produce consistent but incorrect patterns of responding on tests for equivalence may often pass tests for transformation of functions (e.g., Smeets & Barnes-Holmes, 2003), suggesting that such tests are another form of equivalence test (Sidman, 1994). Future research should address these issues. Second, alternative experimental designs, such as pretest–posttest or multiple probes, should be considered in order to rule out competing sources of stimulus control (see Dymond & Rehfeldt, 2000, pp. 246–247). Another possibility would be to expand the derived relations from the present two 3-member relations to three 3-member relations in which one relation is not targeted during function training. Doing so, with the addition of a pretest or probe assessment of all requisite derived relations, would strengthen the demonstration of experimental control and warrants further attention.

As outlined in the introduction, demonstrating that transformation of functions occurs during children's pregambling game playing may contribute towards the behavior-analytic understanding of gambling behavior and help provide verbally based interventions to overcome disordered gambling. Experimental research on gambling, while growing, is dominated by cognitive-based theories, models, and treatment strategies (Nastally & Dixon, 2010; Petry, 2009; Sevigny & Ladouceur, 2003) that emphasize predisposing factors such as personality factors and erroneous beliefs that may lead an individual to develop pathological gambling. The growing body of behavior-analytic research on gambling behavior is concerned with understanding the basic behavioral processes that, for instance, evoke responding in children during pregambling activities (e.g., board games, rolling dice) that formally resemble such responding in adult pathological gamblers (Ghezzi, Lyons, Dixon, & Wilson, 2006; Knapp & Crossman, 2006; Weatherly & Dixon, 2007).

Derived relational responding and the transformation of stimulus functions are likely processes through which gambling behavior that at first appears to be insensitive to underlying reinforcement contingencies may subsequently come to be established in a gambler's repertoire. In modern behavior therapies (e.g., Hayes, Strosahl, & Wilson, 1999), metaphors and experiential exercises are used to undermine the derived transformation of response functions (e.g., Masuda, Hayes, Sackett, & Twohig, 2004). Specifically, these techniques alter the verbal/relational contexts that enable derived transformation to occur, rather than seeking to alter the structure or content of specific verbal relations directly (Blackledge, 2007). With pathological gambling, this could involve repeating aloud a single word or gambling related phrase (such as "casino" or "I'm a failure") to make the direct stimulus functions of words more salient. Such a strategy is thought to increase the behavioral control exerted by several nonproblematic stimulus functions relative to the those problematic response functions derived in accordance with verbal relations. Simultaneously, such techniques can produce extinction of derived stimulus functions (Roche, Kanter, Brown, Dymond, & Fogarty, 2008). The present findings indicate how pervasive these derived stimulus functions can be, even in influencing the behavior of children playing a simulated board game. It is likely, therefore, that contemporary techniques will require additional behavioral interventions, such as defusion techniques, to maintain the effects of treatment contingencies (Petry, Wienstock, Ledgerwood, & Morasco, 2008; Wilson & Murrell, 2004). However, this suggestion is at present somewhat speculative. Much work remains to be conducted on the impact of derived relational responding on gambling behavior in order to continue to formulate the empirical basis of verbally based interventions for altering disordered gambling.

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