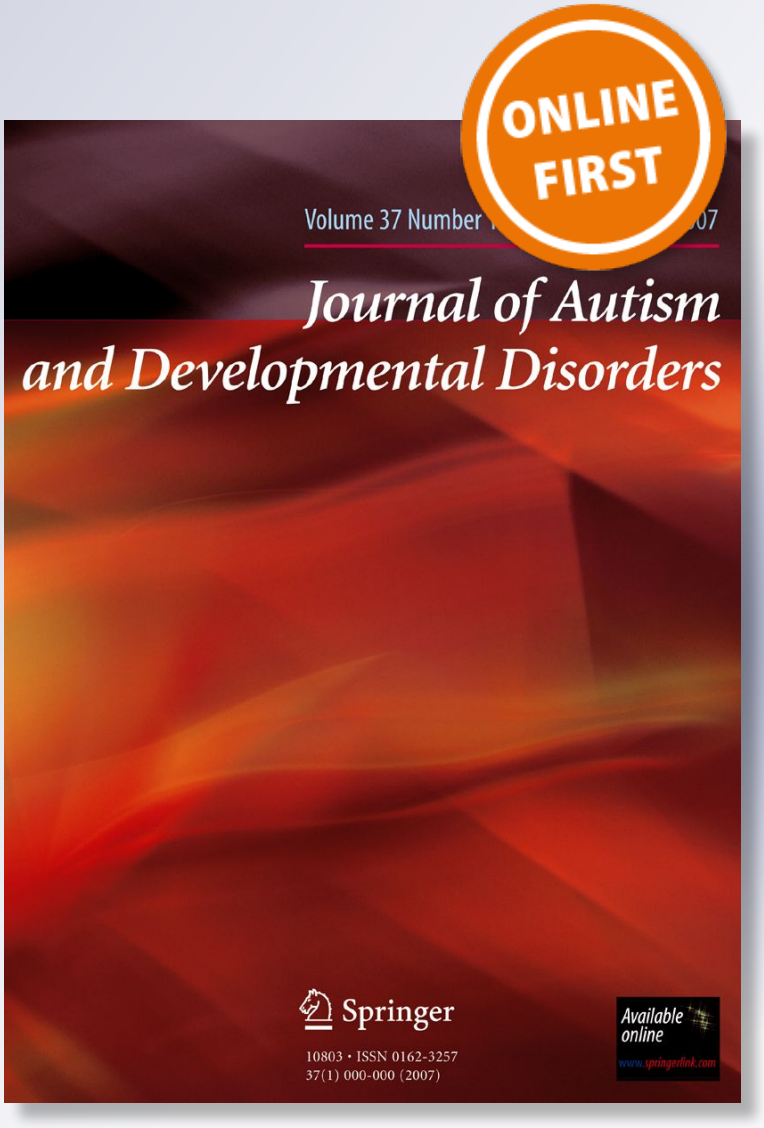
# *Brief Report: Effects of Tact Training on Emergent Intraverbal Vocal Responses in Adolescents with Autism*

**Richard J. May, Emma Hawkins & Simon Dymond**

**Journal of Autism and Developmental Disorders**

ISSN 0162-3257

J Autism Dev Disord
DOI 10.1007/s10803-012-1632-7




Springer

J Autism Dev Disord
DOI 10.1007/s10803-012-1632-7

BRIEF REPORT

# Brief Report: Effects of Tact Training on Emergent Intraverbal Vocal Responses in Adolescents with Autism

**Richard J. May · Emma Hawkins · Simon Dymond**



**Abstract** The present study evaluated the emergence of intraverbal responses following tact training with three adolescents diagnosed with autism spectrum disorders. Participants were taught to tact the name of a cartoon character (e.g., "What is the name of this monster?" ["Simon"]) and that character's preferred food (e.g., "What food does this monster eat?" ["Chips"]). Following tact training, test probes revealed the emergence of untrained vocal intraverbals. Specifically, in the absence of pictures, participants stated the name of the character when given the food preference (e.g., "Which monster eats chips?"), and stated the food when given the character name (e.g., "What food does Simon eat?"). The findings are discussed with reference to the growing literature on verbal behavior and derived relational responding.

**Keywords** Tact training · Intraverbals · Conversation · Emergent · Stimulus relations

## Introduction

A growing body of evidence supports the educational utility of Skinner's (1957) analysis of language to instruction with individuals with autism spectrum disorders (ASD) and other developmental disorders (Greer and Ross 2008; LeBlanc et al. 2009; Sundberg and Michael 2001). Research has, however, tended to focus on some of the verbal operants described by Skinner more than others, with only a few studies investigating the intraverbal relative to the mand, tact and echoic (Sautter and LeBlanc 2006). An intraverbal is an instance of verbal behavior made in response to a verbal stimulus, where the stimulus and response bear no point-to-point correspondence (e.g., answering "Cardiff" when asked, "what is the capital of Wales?"). Establishing vocal intraverbal responses is often an important educational goal for individuals with ASD and impaired language. According to Greer and Ross (2008), "by engaging children in more complex intraverbals, their senses are extended through the spoken words of others; thus they can vicariously experience what others tell them. Complex intraverbals allow them to learn about the weather, who the new person is on the block, what's for dinner, the latest information about others, and even the experiences that others are having." (p. 183). In this way, learning to respond exclusively to the verbal behavior of another speaker, via intraverbals, is crucial in navigating social interactions and sustaining conversation (Skinner 1957).

A synthesis of Skinner's taxonomy of verbal operants, such as intraverbals, with concepts from stimulus equivalence and derived relational responding may prove useful in facilitating communication skills in children with language impairment (Barnes-Holmes et al. 2000; May and Dymond in press; Murphy et al. 2005; Stromer and Vogt 2009; Rosales and Rehfeldt 2009). Traditionally, behaviourally based interventions have primarily involved systematically targeting individual language skills by applying behavioural principles, such as shaping/fading,

The present study was conducted as part of the first author's doctoral research under the supervision of the third author.

R. J. May (✉) · S. Dymond
Department of Psychology, Swansea University, Singleton Park, Swansea SA2 8PP, UK
e-mail: 471864@swansea.ac.uk

E. Hawkins
Jigsaw CABAS School, Dunsfold Park, Stovolds Hill, Cranleigh, Surrey GU6 8TB, UK

Published online: 25 August 2012

differential reinforcement, extinction and stimulus control to the acquisition and maintenance of particular discrete responses (Sundberg and Partington 1998). In contrast, derived relational responding refers to learning outcomes that occur in the absence of a direct history of reinforcement. The basic finding is as follows. After learning a series of conditional discriminations with physically dissimilar (i.e., arbitrary) stimuli, the stimuli involved often become related to one another in ways not explicitly trained. For example, if choosing Stimulus B (e.g., a picture of a car) in the presence of Stimulus A (e.g., the spoken word "car"), is taught (i.e., A–B), and choosing Stimulus C (e.g., the written word/CAR/) in the presence of Stimulus A is also taught (i.e., A–C), it is likely that untrained relations will emerge between B and C, and C and B, in the absence of further feedback. That is, participants will select the picture of the car when given the written word, and vice versa (LeBlanc et al. 2003; Miguel et al. 2009; Sidman 1994).

The extensive research undertaken on such untrained, yet predictable, outcomes was first described by Sidman (1971) and has since become known as the 'stimulus equivalence' paradigm. More recently, the term 'derived relational responding' has been used to refer to research in the behavioral literature examining a broad range of emergent learning outcomes, that include work on stimulus equivalence (Dymond et al. 2010). Combining Skinner's (1957) taxonomy of verbal operants with the emergent outcomes illustrative of stimulus equivalence research may, then, have potential for establishing functional communicative repertoires that need not be individually and directly taught (Rehfeldt and Barnes-Holmes 2009).

A number of studies have examined emergent stimulus equivalence relations involving intraverbals following tact training in typically developing children. In tact training, producing a spoken name (e.g., "Bob") in response to a nonverbal visual stimulus (e.g., a cartoon character) is reinforced (Braam and Sundberg 1991; Partington et al. 1994). Emergent intraverbal responses often result from such a history of tact training (Petursdottir et al. 2008b; Petursdottir and Haflidadottir 2009). For instance, Petursdottir and colleagues first taught children to tact pictures of common items in a foreign language (e.g., "What is this animal called in Spanish?" [picture of a dog]) before subsequently testing for emergent intraverbal relations between the native language and a foreign language stimuli (e.g., "What is 'dog' in Spanish?"), and vice versa (e.g., "What does 'perro' mean?"). In both studies, increases in native-to-foreign and foreign-to-native language intraverbal responses emerged following tact training (Petursdottir et al. 2008b; Petursdottir and Haflidadottir 2009).

Emergence of novel intraverbal responses has also been investigated in studies with individuals with ASD (Grannan and Rehfeldt, in press; Perez-Gonzalez et al. 2007). For instance, Perez-Gonzalez et al. taught two children to respond to several statements involving antonyms. For example, when presented with the instruction "Name the opposite of more" (the 'original' relation), the children were given intraverbal training to answer, "less". Following mastery of this trained relation, emergence of the untrained 'reversed' relation was tested (e.g., "Name the opposite of less"). Initially, neither participant demonstrated emergence of the untrained relations. Participants were then given bidirectional intraverbal training to respond correctly to both the original and reversed relations across a number of exemplars of antonyms. Responding during the test probes conducted with a new stimulus set demonstrated that reversed relations emerged without any further training. Perez-Gonzalez et al. (2007) suggested that the explicit training with the reversed relations over successive sets of stimuli had the effect of establishing the words "is the opposite of" as a contextual cue.

The findings of Petursdottir et al. and Perez-Gonzalez et al. highlight how tact training and bidirectional intraverbal training may yield novel intraverbal forms in both typically developing children and children with ASD. Perez-Gonzalez et al. trained and tested participants on relations involving only two stimuli (i.e., train A–B and B–A emerges), while Petursdottir et al. utilized an existing A–B relation (where A was a picture of a common item and B was the native name for that item), added a further A–C relation (where C was the foreign language name for that item), and subsequently tested for B–C and C–B emergent intraverbal relations. The present study sought to extend this research by examining the emergence of intraverbal responses in adolescents with ASD and language impairment following explicit tact training. Specifically, the study sought to evaluate the effects of tact training involving three stimuli (A–B and A–C training) on the emergence of new untaught intraverbal (B–C and C–B) vocal responses.

## Method

### Participants and Setting

Three male adolescents with an independent diagnosis of ASD were recruited from a school for children and young people with special educational needs. Participants were formally assessed using the *British Picture Vocabulary Scale-Second Edition* (BPVS-II; Dunn et al. 1997). Jon was an 11 year old with an age equivalent score of 5 years and 11 months (standardized score of 58). Rob was a 16 year old who obtained an age equivalent score of 9 years and 7 months (standardized score of 63). Sam was a 15 year old with an age equivalent score of 5 years and 5 months

(standardized score of below 40). Additional participant information was obtained from academic attainment records. Jon was working at National Curriculum (Department for Education and Employment 1999) level 2A for Speaking and Listening, 2B for Reading, and 2C for Writing. Rob was currently working at level 1A for Speaking and Listening, 2C for Reading, and 2C for Writing. Finally, Sam was working at level 3 for Speaking and Listening, 2C for Reading and 2C for Writing. The school's Director of Education and the Department of Psychology Ethics Committee approved the study. Signed, informed consent was obtained from participants' parents prior to commencing data collection. All sessions took place in an empty room in the school containing only tables and chairs.

## Experimental Stimuli, Dependent Variables, and Interobserver Agreement

Stimuli included both experimenter-delivered spoken words and pictures. During pre-training, the picture stimulus consisted of a colour illustration of a monkey. During training and testing, the picture stimuli comprised of two fictitious character color illustrations. Each picture stimulus measured 5 × 5 cm, was card-mounted and covered in adhesive-backed plastic. All other stimuli consisted of vocal utterances that served as both stimuli and responses (see Table 1 for details). A three-ring binder (UK A4 size) with a strip of Velcro® attached to the centre allowed the presentation of sample picture stimuli. A plastic plate, glass jar and thirty marbles were also used during the delivery of feedback.

The primary dependent variable was the percentage of correct vocal utterances during unreinforced test trials for emergent relations during *Pre-* and *Post-test* sessions (termed B–C and C–B trials, respectively). In the present study, emergent B–C relations were assessed by asking participants to state the name of a food (C), given the character name (B), and emergent C–B relations were assessed by asking participants to state the name of the character (B), given the name of the food (C). Both of these relations are referred to as *emergent intraverbal relations*. For both B–C and C–B emergent relations trials, a correct response was scored when the child uttered the correct vocal response (i.e., when the child uttered the target word or an understandable approximation of the word).

An additional dependent measure was the percentage of correct responses for trained relations during A–B and A–C training phases. A–B relations, reinforced during training phases, involved the participant stating the correct character name (B) when presented with the picture of the character (A). A–C relations involved the participant stating the food name (C) following presentation of the character picture (A). Both of these trial types can be defined as *directly trained tact relations*. For the reinforced tact trials, a correct response was scored when the participant uttered the target word or an understandable approximation of the word.

Interobserver agreement was calculated for all training and testing sessions by dividing the number of trials on which the experimenter and a second observer agreed on the outcome (i.e., agreements), by the sum of the agreements and disagreements, multiplied by 100. Interobserver agreement scores were 100 % for Jon and Rob, and 98 % for Sam (range 87–100 %).

## Experimental Design

A nonconcurrent multiple baseline across participants design (Harvey et al. 2004; Watson and Workman 1981) was used to evaluate the effects of tact training on emergence of intraverbal responses. Figure 1 provides an example of the tact and intraverbal relations examined during the study. The order of the experimental phases was as follows: *Pre-training, Pre-test, Training 1, Training 2, Training 3, Training 4, and Post-test*.

## Procedure

Before the first session, participants were presented with the empty jar and the plastic plate containing thirty marbles and asked if they would like to play a game to win a pre-selected

**Table 1** Trained and tested relations, experimenter-delivered spoken stimuli, and correct responses

| Type | Relation | Stimuli | Response |
|---|---|---|---|
| Trained | A1–B1 | "What is the name of this monster?" + cartoon picture 1 | "Simon" |
| Trained | A2–B2 | "What is the name of this monster?" + cartoon picture 2 | "Rocky" |
| Trained | A1–C1 | "What food does this monster eat?" + cartoon picture 1 | "Chips" |
| Trained | A2–C2 | "What food does this monster eat?" + cartoon picture 2 | "Apple" |
| Tested | B1–C1 | "What food does Simon eat?" | "Chips" |
| Tested | B2–C2 | "What food does Rocky eat?" | "Apple" |
| Tested | C1–B1 | "Which monster eats chips?" | "Simon" |
| Tested | C2–B2 | "Which monster eats apple?" | "Rocky" |

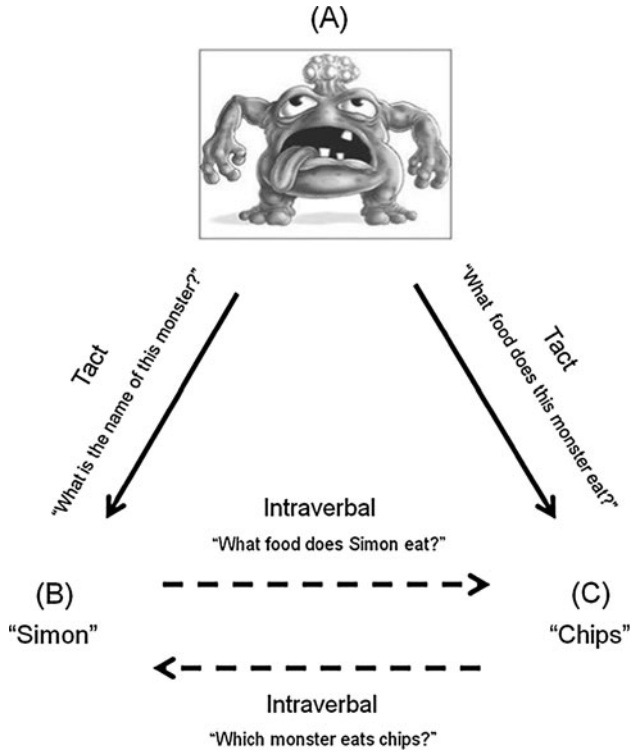



**Fig. 1** Outline of the tact and intraverbal relations trained and tested. *Solid arrows* indicate trained relations and the *dashed arrows* indicate tested, predicted relations

prize from an array of small items (e.g., a figurine, magazine, etc.). If the participant indicated that he wished to continue, the experimenter explained that to win a prize, he would need to "win" all of the marbles by performing the tasks correctly: "During the game, each time you get the answer correct, I will tell you to take a marble from the plate and put it in the jar. Once all of the marbles have been moved from the plate to the jar, you will have won the prize!" After participants indicated they understood the rules of the game, they were asked to select one of the small prizes, which remained in view until all marbles were moved. During the tasks and following the transfer of all of the marbles from the plate to the jar, the experimenter immediately said "Well done! You have won the prize" and presented the toy to the participant, who then selected another prize.

*Pre-Training*

*Pre-training* involved the presentation of familiar stimuli in order to provide exposure to the instructions presented in the subsequent *Pre-test.* The instructional tasks used during *Pre-training* were designed to closely resemble the *Pre-test* probes for tacts (A–B and A–C relations) and intraverbals (B–C and C–B relations) but used real-world stimuli, rather than the experimenter determined (arbitrary) stimuli to be used in the subsequent training and testing. The *Pre-test* was administered to mitigate against any subsequent failure to respond correctly during the *Pre-test* being attributed to lack of instructional control or lack of familiarity with the procedures.

The phase involved the presentation of four individual tasks in a block of four trials. During tasks designed to resemble A–B tact training, the experimenter covertly placed a picture of a monkey on the sample space of the stimulus presentation binder. A trial began when the experimenter placed the stimulus presentation binder in front of the participant and said, "Can you touch the picture?" This served as an observing response to ensure that the participant had attended to the sample stimulus. When the participant touched the picture, the experimenter asked, "What is the name of this animal?" If the correct tact response was produced (i.e., saying "monkey"), the experimenter said "Well done! That is the correct answer, take a marble." If the incorrect name was produced or the participant did not respond within 10 s, the experimenter said, "That is not the right answer. The correct answer is 'monkey'." On these occasions, the experimenter did not instruct the participant to take a marble.

During tasks designed to resemble A–C training, the experimenter covertly attached the picture to the presentation binder and presented the stimulus as before. Once the participant had made the observing response, the experimenter said, "What food does this animal eat?" If the participant produced the correct vocal utterance (i.e., saying "banana"), the experimenter said "Well done! That is the correct answer, take a marble." If the participant responded incorrectly or did not respond, the experimenter said, "That is not the right answer; the correct answer is 'banana'." On these occasions, the experimenter did not instruct the participant to take a marble.

During tasks designed to resemble B–C tests, the experimenter merely delivered a vocal stimulus by asking, "What food does the monkey eat?" If the participant responded with the correct utterance (saying "banana") the experimenter delivered a marble or corrected as before, and recorded whether the response was correct or incorrect. Finally, during the training tasks designed to approximate the C–B tests, the experimenter asked, "What animal eats bananas?" If the participant responded with the correct response ("monkey") the experimenter delivered a marble, and if the participant was incorrect the experimenter responded as before. The criterion for this phase was met when 100 % correct responses occurred across all trials within one trial-block (i.e., four out of four correct).

*Pre-Test*

During the *Pre-test*, participants were exposed to both tact (A–B, A–C), and intraverbal (B–C, C–B) trials in the

absence of feedback. An A–B trial consisted of asking participants to give the name (B) of the character when shown a picture of the character (A). An A–C trial consisted of asking participants to state the name of a food (C) when shown a picture of the character (A). A B–C trial consisted of asking participants to state the name of a food (C) when told the name of the character (B). Finally, a C–B trial consisted of asking participants to state the name of the character (B) when told the name of a food (C). Prior to the *Pre-test* it was explained that no feedback would be given, but marbles were still available for on-task behavior and compliance with mastered instructions (e.g., "Can you give me a high five?"), regardless of test performance. During the *Pre-test* sessions, marbles were delivered for on task behavior, and responses to mastered instructions, at an average of four times per block (33 % of total trials).

Each *Pre-test* block consisted of eight trials that probed each relation once (A1–B1, A2–B2, A1–C1, A2–C2, B1–C1, B2–C2, C1–B1, C2–B2; see Table 1). No consequences or correction procedures followed any trial, regardless of performance. Following either the participant's response or a period of 10 s, whichever came first, the experimenter covertly recorded the response and prepared the stimuli for the next trial. It took approximately 3 s to present the next trial (i.e., intertrial interval). The order of presentation of trials was randomised across participants. As the responses during *Pre-test* served as a baseline measure, blocks were administered repeatedly for a pre-determined number of times for each participant. The number of baseline *Pre-test* blocks was determined a priori. All relations trained and tested during the study (between pictures, names, and food preferences) were experimenter-determined and, as such, were entirely arbitrary. It was therefore predicted that participants' responding during *Pre-test* blocks would be at, or below, chance levels (50 %). This was verified via visual inspection of the level of responding, prior to discontinuing the pre-test phase for each participant. As such, three, five, and seven *Pre-test* blocks were administered to Jon, Rob, and Sam, respectively.

*Training 1 (A–B Tact Training)*

*Training 1* was introduced in a staggered fashion across participants in accordance with the multiple baseline design. The purpose of this phase was to teach participants to state/tact the name of the character given the picture of the character (A–B training). Prior to *Training 1,* participants were informed they would be able to earn marbles for correct answers. Training was conducted in 8-trial blocks whereby each of two tact relations was presented four times (A1–B1, A2–B2). Trials were varied within each block in a quasi-randomised fashion, with the constraint being that no more than two consecutive trials of the same type could occur. During A–B tact trials, the experimenter presented the picture of the character and asked the participant to touch the picture. Following this observing response, the experimenter asked, "What is the name of this monster?" and waited for up to 10 s for a vocal response. A response was deemed correct if the participant said either "Simon", when presented with cartoon picture 1 or "Rocky", when presented with cartoon picture 2. Correct responses were followed by social praise and the instruction to take a marble. Incorrect responses were followed by corrective feedback: "That is not the right answer. The right answer is Rocky [Simon]." Participants were not required to repeat the response modelled by the experimenter and were not instructed to take a marble. A minimum of seven out of eight trials correct was required to progress to the next training phase.

*Training 2 (A–C Tact Training)*

The purpose of *Training 2* was to teach the A–C training relations in the same format as *Training 1*. As before, training relations were presented in blocks of eight trials whereby each of the two tact relations was presented four times each (A1–C1, A2–C2). During A–C training, the experimenter presented the picture of the character, prompted an observing response, and then asked, "What food does this monster eat?" A response was deemed correct if the participant said either "chips" when presented with cartoon picture 1 or "apple", when presented with cartoon picture 2. Correct responses were again followed by social praise and the instruction to take a marble, while incorrect responses were followed by corrective feedback and no instruction to take a marble. Participants were required to respond correctly on a minimum of seven out of eight trials in order to progress to the next training phase.

*Training 3 (Mixed A–B and A–C Tact Training)*

*Training 3* interspersed the trial types from *Training 1* and *Training 2.* Trials were presented in blocks of eight trials, with each trial type (A1–B1, A2–B2, A1–C1, A2–C2) being presented twice in a quasi-randomised fashion. Correct and incorrect responses were consequated in the same way as *Training 1* and *2.* Participants were required to respond correctly on a minimum of seven out of eight trials in order to progress to the next training phase.

*Training 4 (Mixed A–B and A–C Tact Training: 50 % Feedback)*

The purpose of this phase was to reduce the proportion of trials followed by feedback in order to approximate the rate

of feedback to be presented during the *Post–test*. *Training 4* consisted of the same trial types presented during *Training 3*. During this phase, however, participants were required to respond in the absence of feedback for 50 % of the total number of trials within each trial block. In addition, the number of the trials in each block increased from eight to sixteen trials. Prior to this phase, participants were instructed: "In this game you are going to be told to take a marble only after some of the answers; sometimes, even if you get the answer correct, I will not tell you if you were right and I will not ask you to take a marble, do you understand?" Trials to be reinforced were predetermined and randomized within each trial block. When trials without feedback occurred, the experimenter provided no feedback following responses. Following the presentation of reinforced trials the experimenter provided social praise and instructions to take a marble on occasions when the participant was correct, and corrective feedback following instances when the child was incorrect. The criterion for passing this phase was a minimum of fourteen out of sixteen correct trials (i.e., 87.5 %).

*Post-Test*

This phase was designed to assess the accuracy of participants' responding across a combination of reinforced baseline (tact) trials and emergent intraverbal test trials without feedback. The presentation of each of the trials during the *Post-test* was identical to the procedure carried out during the *Pre-test* phase, the only exception being the delivery of feedback for baseline (tact) trials. As such, the *Post-test* was conducted in 8-trial blocks, with each block consisting of one presentation of each of the trial types (A1–B1, A2–B2, A1–C1, A2–C2, B1–C1, B2–C2, C1–B1, C2–B2; see Table 1). However, feedback was only delivered for correct responding on baseline (A–B, A–C) trials. As with *Training 4,* participants were informed prior to the *Post-test* that marbles would be delivered for some, but not all, responses.

## Results

Pre-Training

Both Jon and Sam responded correctly on 100 % of trials, while Rob reached mastery criterion on the second block of trials. These data indicate that all participants possessed a pre-existing repertoire of intraverbals and tacts with respect to familiar objects.

Pre-Test

Figure 2 shows the percentage of correct responses for each relation during both *Pre-test* and *Post-test* sessions. During *Pre-test*, Jon responded between 0 and 50 % accuracy on baseline and emergent relations probes, with a mean of 33 % accuracy for emergent relations and 42 % accuracy for baseline relations. Rob responded between 0 and 50 % accuracy during test blocks for both emergent relations and baseline relations, with a mean of 25 % accuracy for emergent relations probes and 15 % accuracy for baseline relations over the five sessions during the *Pre-test*. Sam responded at 25 % accuracy for baseline relations during all seven *Pre-test* sessions, and between 0 and 50 % accuracy for the emergent relations probes. Sam responded with a mean 21 % accuracy for emergent relations probes during the *Pre-test*. Thus, all participants responded at, or below, chance levels during the *Pre-test*, indicating that the specific to-be-trained and –tested tact and intraverbal skills involving the experimental stimuli, were absent. Moreover, the requirements of the multiple baseline design ensured that performances were stable and that the number of exposures to the *Pre-test* trials varied across participants prior to commencing training and testing (Fig. 2).

Training 1–4

Both Jon and Rob required one block of training in each of the four training phases in order to meet criterion. Sam required three blocks of *Training 1*, two blocks of *Training 2*, and one block of trials in *Training 3* and *Training 4* before reaching criterion. All participants completed the entire training sequence within a single, 20-min session.

Post-Test

During *Post-test*, all participants responded at 100 % accuracy for the baseline relations in all test blocks (Fig. 2). In addition, all three participants responded at 100 % accuracy in the emergent relations test probes for all but one of the test blocks. The exception to this was Jon who responded at 75 % accuracy (i.e., one error) during the B–C emergent intraverbal tests. Overall, the *Post-test* data demonstrate the emergence of emergent intraverbal responses following tact training in adolescents with autism.

## Discussion

The goal of the present study was to evaluate the effects of tact training on emergent intraverbal responses with adolescents with ASD and language impairment. All three participants demonstrated emergent vocal intraverbals, in the form of correctly answering questions, immediately following an instructional history of tacting pictures. The specific intraverbal responses that were established

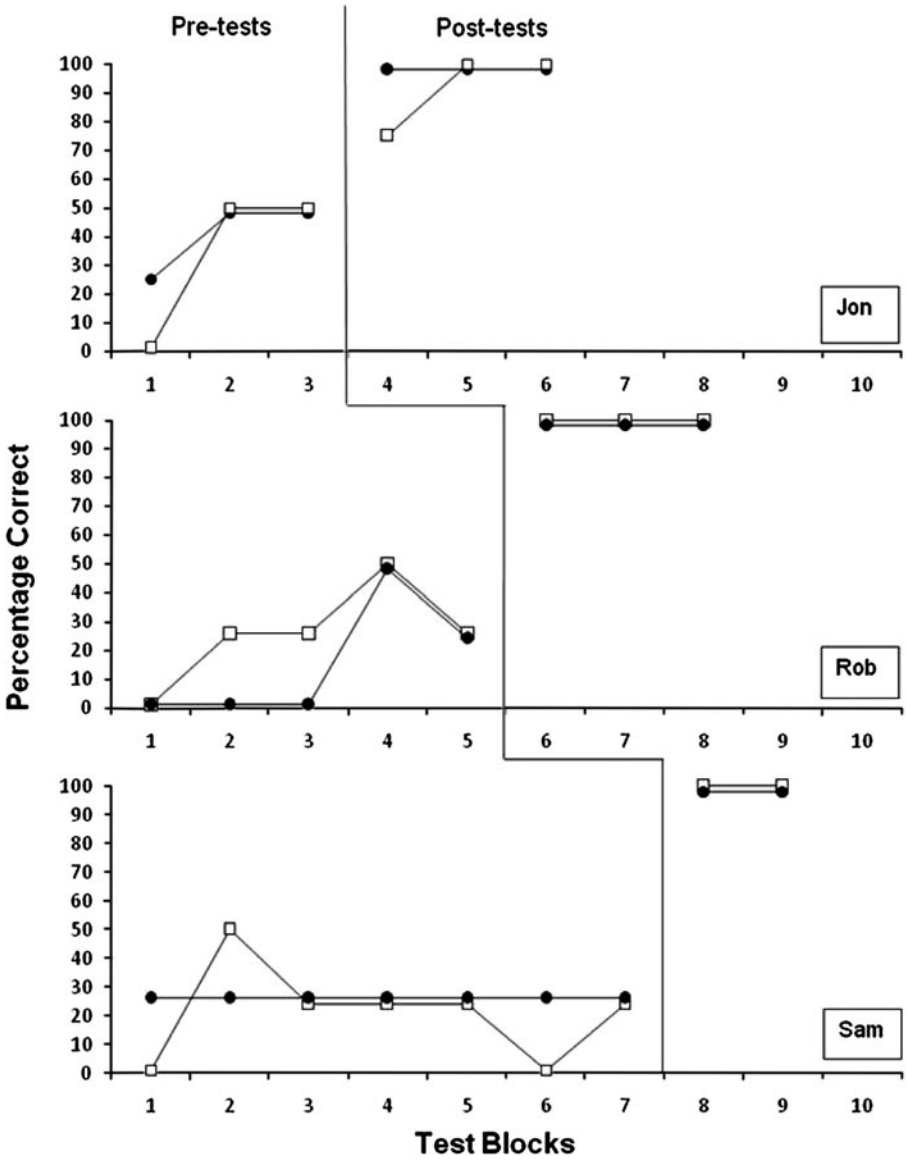



**Fig. 2** Percentage correct during *Pre-test* and *Post-test* for all three participants. The solid phase change line represents the staggered introduction of the training intervention. *Filled circles* indicate taught baseline relations (tacts) and *open squares* indicate emergent relations (intraverbals)

emerged in the absence of explicit intraverbal training and did so only after a subset of other verbal operants (i.e., tacts) was taught. These findings add to the growing literature on derived relational responding and verbal behavior (e.g., Barnes-Holmes et al. 2000; Rehfeldt and Root 2005; Rosales and Rehfeldt 2009).

The present findings may have implications for curriculum design aimed at increasing the generativity of vocal skills, which is a key challenge in special education (Stromer and Vogt 2009). A critical feature of the tact training relations in the present study was that all three experimental stimuli (A [character pictures]; B [character names]; C [food names]) were incorporated into the instructional sequence. This approach facilitated the emergence of relations between stimuli (B [food names] and C [character names]) over and above those relationships that were explicitly taught (A [character pictures] to B [character names] and C [food names], respectively). Had we selected two training relations that involved only two of the stimuli (e.g., the two intraverbal relations), then this would not have resulted in further emergent outcomes. Instead, by ensuring that the trained tact relations involved an overlapping element (A), it was possible to demonstrate emergent vocal skills when participants were asked relevant questions about the other, indirectly related stimuli. It is common for behaviourally orientated language intervention guides to emphasize the explicit teaching of all language forms (Lovaas 2002; Sundberg and Partington 1998). This may present a serious practical challenge given the volume of teaching trials required to teach every component part of a linguistic repertoire. The findings reported here highlight the potential educational benefits that may result from careful planning of both the sequence and type of stimulus relations/verbal operants used in

teaching in order to maximize the potential for untrained skills to emerge (Rosales and Rehfeldt 2009; Stromer and Vogt 2009).

In previous studies, Petursdottir et al. (2008b) and Petursdottir and Haflidadottir (2009) both reported that vocal intraverbals emerged with typically developing children following training to tact items in a foreign language. For instance, Petursdottir et al. adapted an existing picture (A) to native language name relation (B; A–B) and then trained a picture (A) to foreign language name (C; A–C) relations before then testing for B–C and C–B emergent intraverbal relations. Consistent with this approach, the present study demonstrated, for the first time, that tact training involving at least three stimuli may generate emergent vocal intraverbals in adolescents with ASD and impaired receptive language. The intraverbal responses that emerged were specific to the trained and tested stimuli, and were not based on pre-existing tact or intraverbal relations with the experimental stimuli. Moreover, the findings show that participants' tacting and intraverbal repertoires, which were assessed during pre-training and found to be intact, readily generalised to the training and testing stimuli chosen by the experimenter. This suggests that a minimal tacting and/or intraverbal repertoire may have been either a necessary or sufficient condition for the present performances to emerge. The role of pre-existing tact and intraverbal repertoires in generating emergent outcomes, such as those seen in the present study and those of Petursdottir and colleagues (2008b, 2009), is an issue that warrants further empirical attention.

Consistent with previous research (e.g., Petursdottir et al. 2008b; Petursdottir and Haflidadottir 2009), the training protocol utilized in the current study was referred to as tact training. It may be more conceptually systematic, however, to describe the procedures as involving *tact-intraverbal* training. The vocal responses that emerged were likely to have come under the control of combined tact and intraverbal elements. That is, the vocal responses were part tact as they occurred under the control of a nonverbal feature of the environment (e.g., the cartoon character), but also part intraverbal as they occurred in response to a specific verbal stimulus (e.g., "What is the name of this monster?"). In this way, the responses came to be controlled by the particular question that accompanied the presentation of each picture: during training, the pictures functioned as discriminative stimuli and the particular question exerted conditional or contextual control (Barnes-Holmes et al. 2000).

Participants passed tests for emergent intraverbal relations largely without error and, as such, these findings add to the range of procedures that synthesise verbal behavior and derived relational responding. In previous studies, intraverbal responses have not always emerged after training with other verbal operants (e.g., Miguel et al. 2005; Petursdottir et al. 2008a). Further research is needed to examine the reasons for these apparent discrepancies by, for instance, investigating the extent to which existing language abilities contribute to derived relational responding performance (O'Donnell and Saunders 2003). In the present study, the participants had limited receptive vocabularies relative to chronological ages, yet the pre-training phase indicated they possessed relevant tact and intraverbal abilities. While participants' BPVS-II scores might suggest limited receptive vocabularies, all three participants performed at high, stable levels of responding during the crucial tests for emergent intraverbal responses. Clearly, further research is needed to delineate the nature of the relationship between existing language abilities and the types of outcomes observed in the present study.

A possible limitation of the present findings concerns the stability of Jon's and, to lesser extent, Rob's, *Pre-test* responding (Fig. 2), both of which indicate an increasing trend. Extending the duration of *Pre-test* for these participants may well have mitigated any concerns regarding experimental control, but it is important to note that there was a distinct and immediate change in the level of correct responding following the intervention. Future research examining derived intraverbal responses should seek to ensure stability of baseline responding prior to intervention.

In summary, following training to answer questions in the presence of a picture of a cartoon character, participants were able to answer questions about the character in the absence of the picture, without further teaching. These findings illustrate the potential for verbal behavior and derived relational responding procedures to be utilized in teaching important language skills. Developing procedures that facilitate flexible verbal repertoires that generalize beyond both the particular stimuli used in training, and the specific context in which they were trained, may be seen as a critical goal. Such skills may then receive social support in the verbal community outside of the teaching setting, an important educational outcome for individuals with autism and other developmental disabilities (Stromer and Vogt 2009).

**Acknowledgments** The research was supported by a Sidney W. and Janet R. Bijou Fellowship award (2011) to the first author from the Society for the Advancement of Behavior Analysis (SABA). The authors thank Einar Ingvarsson and several anonymous reviewers for comments on an earlier version of this article.

## References

Barnes-Holmes, D., Barnes-Holmes, Y., & Cullinan, V. (2000). Relational frame theory and Skinner's *Verbal Behavior*: A possible synthesis. *The Behavior Analyst, 23*, 69–84.

Braam, S. J., & Sundberg, M. L. (1991). The effects of specific versus nonspecific reinforcement on verbal behavior. *The Analysis of Verbal Behavior, 9*, 19–28.

Department for Education and Employment (DfEE)/Qualifications and Curriculum Authority (QCA). (1999). *The National Curriculum*. London: QCA.

Dunn, L. M., Dunn, L. M., Whetton, C., & Burley, J. (1997). *The British Picture Vocabulary Scale (II)*. London: Nelson.

Dymond, S., May, R. J., Munnelly, A., & Hoon, A. E. (2010). Evaluating the evidence base for relational frame theory: A citation analysis. *The Behavior Analyst, 33*, 97–119.

Grannan, L., & Rehfeldt, R. A. (in press). Emergent intraverbal responses via tact and match-to-sample instruction. *Journal of Applied Behavior Analysis*.

Greer, R. D., & Ross, D. E. (2008). *Verbal behavior analysis: Inducing and expanding new verbal capabilities in children with language delays*. New York: Allyn and Bacon.

Harvey, M. T., May, M. E., & Kennedy, C. H. (2004). Nonconcurrent multiple baseline designs and the evaluation of educational systems. *Journal of Behavioral Education, 13*, 267–276.

LeBlanc, L. A., Dillon, C. M., & Sautter, R. A. (2009). Establishing mand and tact repertoires. In R. A. Rehfeldt & Y. Barnes-Holmes (Eds.), *Derived relational responding: Applications for learners with autism and other developmental disabilities* (pp. 79–108). Oakland, CA: New Harbinger.

LeBlanc, L. A., Miguel, C. F., Cummings, A. R., Goldsmith, T. R., & Carr, J. E. (2003). The effects of three stimulus equivalence testing conditions on emergent US Geography relations of children diagnosed with autism. *Behavioral Interventions, 18*, 279–289.

Lovaas, O. I. (2002). *Teaching individuals with developmental delays: Basic intervention techniques*. Austin, TX: PRO-ED.

May, R. J., & Dymond, S. (in press). Facilitating emergent verbal repertoires in individuals with autism and other developmental disorders: Insights from behavior analysis. In J. Arciuli & J. Brock (Eds.), *Trends in language acquisition research: Language and communication impairment in childhood autism*. Amsterdam: John Benjamins Publishing Company.

Miguel, C. F., Petursdottir, A. I., & Carr, J. E. (2005). The effects of multiple-tact and receptive-discrimination training on the acquisition of intraverbal behavior. *The Analysis of Verbal Behavior, 21*, 27–41.

Miguel, C. F., Yang, H. G., Finn, H. E., & Ahearn, W. H. (2009). Establishing derived textual control in activity schedules with children with autism. *Journal of Applied Behavior Analysis, 42*, 703–709.

Murphy, C., Barnes-Holmes, D., & Barnes-Holmes, Y. (2005). Derived manding in children with autism: Synthesizing Skinner's *Verbal Behavior* with relational frame theory. *Journal of Applied Behavior Analysis, 38*, 445–462.

O'Donnell, J., & Saunders, K. J. (2003). Equivalence relations in individuals with language limitations and mental retardation. *Journal of the Experimental Analysis of Behavior, 80*, 131–157.

Partington, J. W., Sundberg, M. L., Newhouse, L., & Spengler, S. M. (1994). Overcoming an autistic child's failure to acquire a tact repertoire. *Journal of Applied Behavior Analysis, 27*, 733–734.

Perez-Gonzalez, L. A., Garcıa-Asenjo, L., Williams, G., & Carnerero, J. J. (2007). Emergence of intraverbal antonyms in children with pervasive developmental disorder. *Journal of Applied Behavior Analysis, 40*, 697–701.

Petursdottir, A. I., Carr, J. E., Lechago, S. A., & Almason, S. M. (2008a). An evaluation of intraverbal training and listener training for teaching categorization skills. *Journal of Applied Behavior Analysis, 41*, 53–68.

Petursdottir, A. I., Olafsdottir, A. R., & Aradottir, B. (2008b). The effects of tact and listener training on the emergence of bidirectional intraverbal relations. *Journal of Applied Behavior Analysis, 41*, 411–415.

Petursdottir, A. I., & Haflidadottir, R. D. (2009). A comparison of four strategies for teaching a small foreign language vocabulary. *Journal of Applied Behavior Analysis, 42*, 497–745.

Rehfeldt, R. A., & Barnes-Holmes, Y. (Eds.). (2009). *Derived relational responding applications for learners with autism and other developmental disabilities*. Oakland, CA: New Harbinger.

Rehfeldt, R. A., & Root, S. L. (2005). Establishing derived requesting skills in adults with severe developmental disabilities. *Journal of Applied Behavior Analysis, 38*, 101–105.

Rosales, R., & Rehfeldt, R. A. (2009). Extending functional communication through relational framing. In R. A. Rehfeldt & Y. Barnes-Holmes (Eds.), *Derived relational responding applications for learners with autism and other developmental disabilities* (pp. 237–256). Oakland, CA: New Harbinger.

Sautter, R. A., & LeBlanc, L. A. (2006). Empirical applications of Skinner's analysis of verbal behavior with humans. *The Analysis of Verbal Behavior, 22*, 35–48.

Sidman, M. (1971). Reading and auditory-visual equivalences. *Journal of Speech and Hearing Research, 14*, 5–13.

Sidman, M. (1994). *Equivalence relations and behavior: A research story*. Boston: Authors Cooperative.

Skinner, B. F. (1957). *Verbal behavior*. Acton, MA: Copley.

Stromer, R., & Vogt, R. (2009). The formation and elaboration of stimulus classes. In A. Fitzer & P. Sturmey (Eds.), *Language and autism: Applied behavior analysis, evidence, and practice* (pp. 218–249). Austin, Tex: Pro-Ed.

Sundberg, M. L., & Michael, J. (2001). The benefits of Skinner's analysis of verbal behavior for children with autism. *Behavior Modification, 25*, 692–724.

Sundberg, M. L., & Partington, J. W. (1998). *Teaching language to children with autism or other developmental disabilities*. Pleasant Hills, CA: Behavior Analysts.

Watson, P. J., & Workman, E. A. (1981). The nonconcurrent multiple baseline across individuals design: An extension of the traditional multiple baseline design. *Journal of Behavior Therapy and Experimental Psychiatry, 12*, 257–259.