

Emergent Intraverbal Forms may Occur as a Result of Listener Training for Children with Autism

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Abstract The purpose of the present study was to assess whether intraverbal behavior, in the form of answers to questions, emerges as a result of listener training for five children diagnosed with autism. Listener responses were targeted and taught using prompting and differential reinforcement. Following successful acquisition of listener responses, the intraverbal form of the response was probed. Data were evaluated via a nonconcurrent multiple-baseline design that included a control series. Results showed listener-to-intraverbal transfer for four of the five participants. One participant required additional teaching that involved tacting the items selected during listener training.

Keywords Autism · Emergence · Intraverbal behavior · Listener training · Stimulus control

Background

An important prerequisite for learning complex intraverbal behavior is the discrimination of complex verbal stimuli (Sundberg & Sundberg, 2011). Discriminations of complex verbal stimuli may be facilitated by teaching listener behavior (Eikeseth & Smith, 2013). Previous research, however, has provided mixed results in terms of whether listener training alone may be sufficient for intraverbal responding to emerge. For example, some studies have

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examined effects of listener training on establishing emergent intraverbal categorization in typically developing children, but these studies have failed to find reliable emergent intraverbal categorizations following either listener training, tact training, or intraverbal training (Lechago, Carr, Kismore & Grow, 2015; Miguel, Petursdottir, & Carr, 2005; Petursdottir, Carr, Lechago, & Almason, 2008; Petursdottir & Hafliadottir, 2009; Petursdottir, Olafsdottir, & Aradottir, 2008). Petursdottir and Hafliadottir and Petursdottir, Lepper, and Peterson (2014) showed some increases in intraverbal responding after listener training, though not to criterion performance or for all relations assessed. Further, Petursdottir, Olafsdottir, et al. (2008) showed that listener training increased intraverbal responding, but the emergent relations were not always bidirectional. The two studies (Petursdottir & Hafliadottir, 2009; Petursdottir, Olafsdottir, et al. 2008) that showed some positive effect of listener training on emergent intraverbal responding used stimuli that participants reliably tacted. In contrast, Petursdottir, Carr, et al. (2008) and Miguel et al. did not provide information regarding other verbal operants demonstrated by participants.

The current study examined the extent to which emergent intraverbal forms may occur as a result of listener training for children with autism. The target emergent intraverbal behavior was to answer questions, such as answering “tomato” when presented with the instruction, “What do you eat that is red?” Listener training consisted of teaching participants to select the object tomato when presented with the instruction, “What do you eat that is red?” Before entering the study, participants emitted the target in tact and echoic form, but not as an intraverbal. That is, participants correctly named the object tomato and said “tomato” when presented with the auditory stimulus, “tomato,” but did not say “tomato” in response to the verbal antecedent, “What do you eat that is red?” The present study extends research in the area by including children with autism as participants and measuring the emergence of intraverbal responses that were already emitted as tacts and echoics in participants’ native language.

Method

Participants, Setting, and Materials

Five children (four boys, one girl) diagnosed with autism participated in this study. Participants’ chronological age and standard scores on the Vineland Adaptive Behavior Scales (Sparrow, Cicchetti, & Balla, 2005) and the category of echoics (short sentences, sentences or generalized) and total number of mands, tacts, and intraverbals are shown in Table 1.

All sessions were conducted at the participants’ homes, with the exception of Edward, whose sessions took place in his one-to-one teaching room at school.

Table 2 shows the six intraverbals targeted as listener responses plus two intraverbals that were not targeted as listener responses and, hence, served as control questions. Pictures used during listener training were taken from either Google Images™ or Clip Art in Microsoft Word™ and were selected because they were deemed to be clear and simple depictions of the target intraverbal response. Each picture was approximately 6 cm by 6 cm and in color, presented on a white background. Questions were chosen because they were age appropriate, functional for daily life, and suitable for each participant’s

Table 1 Participants' chronological age in year and standard scores on the Vineland Adaptive Behavior Scales; category of echoic repertoire; and total number of mands, tacts, and intraverbals

Participant	Age	Vineland Adaptive Behavior Scales				Verbal behavior skills			
		Com	DLS	Soc	ABC	Echoic	Mand	Tact	Intraverbal
Robbie	6	89	87	61	78	Sentences	>50	>200	>75
Sarah	5	78	71	61	66	Generalized	>75	>250	>75
Freddie	13	59	57	48	55	Sentences	>40	>150	>50
Edward	12	74	79	73	73	Sentences	>30	>200	>50
Charlie	15	59	62	57	59	Short sentences	>20	>50	>50

Vineland Adaptive Behavior Scales

Com communication subdomain, *DLS* daily living skills subdomain, *Soc* socialization subdomain, *ABC* adaptive behavior composite

current educational curriculum. The intraverbal responses used in the study were all nouns. These nouns were mastered both as listener responding and as tacts.

Dependent Variables

During intraverbal probing, participant responses were scored as correct, incorrect, or as a nonresponse. Correct responses were defined as the participant emitting the targeted vocal response (e.g., if asked: “What do you eat that’s yellow?” the correct response was: “banana”) within 3 s of presentation of the auditory stimulus. Nonresponses were defined as the participant making no vocal response within 3 s of presentation of the auditory stimulus. All other responses were scored as incorrect. During listener training, participant responses were scored in the exact same way except that prompts were added as a scoring option. Prompted responses consisted of physical (hand-over-hand) guidance and pointing.

Interobserver Agreement

Interobserver agreement (IOA) scores were collected by an independent observer during all phases of the experiment. IOA was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. IOA data were collected in 40.7 % of randomly selected sessions across all participants (range, 10.6 to 58.8 %) and mean IOA across all phases, and all participants was 98.9 % (range, 97.5 to 99.5 %).

Procedures

Baseline Intraverbal Probes

Baseline sessions were conducted once per week. The teacher and the participant sat opposite each other, either face-to-face or across a small table, and there were no visual stimuli or teaching materials present. The questions were asked in a random order. If

Table 2 The six intraverbals taught as listener behavior and the two intraverbal control questions for each participant

Participant	Six intraverbals taught as listener behavior	Two untaught intraverbals
Charlie	What's an animal that's grey? (elephant) What's a drink that's white? (milk) What's an animal that flies? (bird) What's a drink that's yellow? (juice) What's a food that's green? (apple) What do you kick that's round? (ball)	What's a vehicle that goes on water? (boat) What's a vehicle with two wheels? (bike)
Freddie	What's furniture that has four legs? (chair) What vehicle has an anchor? (boat) What breathes through gills? (fish) What's a food that's yellow? (banana) What's a drink that's white? (milk) What do you talk into? (telephone)	What plant has bark? (tree) What's a type of vehicle? (train)
Robbie	What animal is nocturnal? (owl) What's a vehicle that flies in space? (rocket) What do you wear around your waist? (belt) What animal has gills? (fish) What shape has one side? (circle) What's a vehicle that goes on water? (boat)	What shape has four sides? (square) What animal is an amphibian? (frog)
Sarah	What animal is an amphibian? (frog) What animal is nocturnal? (owl) What vehicle has a hull? (boat) What animal breathes through gills? (fish) What animal has a baby joey? (kangaroo) What insect collects pollen? (bee)	What vehicle goes into orbit? (rocket) What animal is a mammal? (monkey)
Edward	What has blades? (scissors) What breathes through gills? (fish) What animal is an amphibian? (frog) What vehicle goes into orbit? (rocket) What plant has bark? (tree) What object has prongs? (fork)	What do you use to make tea? (kettle) What animal is nocturnal? (owl)

the participant answered a question incorrectly or gave no response, brief verbal encouragement was provided (e.g., “okay” or “good try”), and the question was re-presented. If a question was answered incorrectly a second time, the same verbal encouragement was provided and the question was presented again. Brief verbal praise statements (e.g., “that’s right!”) were provided for correct responses.

Listener Training

The six target questions were taught using discrete-trial teaching and discrimination training (Eikeseth, Smith, & Klintwall, 2014). The sequence of teaching is shown in Table 3 and was based on the procedures utilized to teach conditional discriminations before participants entered the study. Sessions were conducted during each participant’s usual therapy sessions and were presented to each participant as an activity to be completed alongside their usual learning tasks. Each trial began with the presentation of the question. The participant was given 3 s to respond, and different consequences were provided contingent on different responses to the question.

Table 3 Teaching stages of discrimination training

Training step	Sample stimulus	Sample stimulus order	Comparison stimuli	Comparison stimuli position
1	Q1	Fixed	S1	Fixed
2	Q1	Fixed	S1 S2	Random
3	Q2	Fixed	S2	Fixed
4	Q2	Fixed	S1 S2	Random
5	Q1 Q2	Semi random	S1 S2	Random
6	Q3	Fixed	S3	Fixed
7	Q3	Fixed	S1 S2 S3	Random
8	Q1 Q2 Q3	Semi random	S1 S2 S3	Random
9	Q4	Fixed	S4	Fixed
10	Q4	Fixed	S1 S2 S3 S4	Random
11	Q1 Q2 Q3 Q4	Semi random	S1 S2 S3 S4	Random
12	Q5	Fixed	S5	Fixed
13	Q5	Fixed	S1 S2 S3 S4 S5	Random
14	Q1 Q2 Q3 Q4 Q5	Semi random	S1 S2 S3 S4 S5	Random
15	Q6	Fixed	S6	NA
16	Q6	Fixed	S1 S2 S3 S4 S5 S6	Random
17	Q1 Q2 Q3 Q4 Q5 Q6	Semi random	S1 S2 S3 S4 S5 Q6	Random

The sample stimulus is the question asked by the experimenter. The comparison stimuli are the picture cards placed on the table. For example, when the sample stimulus “What’s a drink that’s white?” was presented, the participant was taught to touch the comparison stimulus of the picture card depicting a glass of milk

Semi random = sample stimuli occurred in random order except that they occurred an equal number of times each

Q question, *S* stimulus, *NA* not applicable

At all times during training, contingent reinforcement was provided for a correct response (i.e., the participant touched/pointed to the correct picture), irrespective of whether or not the participant also correctly or incorrectly tacted the picture while responding to it. Items used as reinforcers were those used in each participant’s usual teaching sessions and were identified as part of those sessions; these included tangibles, tokens, and small pieces of preferred food. Reinforcement always included praise, but verbal praise did *not* contain the noun label shown in the picture. If the participant responded incorrectly, the instructor provided brief verbal encouragement (e.g., “good try”) followed by a point prompt on the subsequent trial. Prompts were faded using a 2-s time-delay procedure. On the next trial, the response was prompted if the participant failed to respond within 2 s of hearing the question. On the third consecutive trial, the prompt was withheld.

The mastery criterion was 90 % correct responding in a block of 10 trials, and following mastery of the six questions in the listener training phase, an intraverbal

probe was conducted. If any participant answered any questions incorrectly during the intraverbal probe sessions (see below), listener training was reinstated before the next intraverbal probe session was conducted. The reason listener training was reinstated was that a failure to show emergent intraverbal behavior could be due to a failure to maintain the baseline relations (i.e., the listener behavior), rather than a failure to show emergent relations per se.

Intraverbal Probes

Following mastery of the six questions in the listener training stage, an intraverbal probe was conducted. This probe was identical to baseline.

Listener Training Plus Verbal Model

If a participant answered more than one question incorrectly after two intraverbal probe sessions, a vocal model was added to the listener training. Training was identical to the original listener training with the exception that the teacher now immediately repeated the label back to the participant each time he touched/pointed to the correct picture on the table. Following mastery of this stage, the intraverbal probe session was conducted and was identical to that described above.

Listener Training Plus Tacting

If a participant continued to answer more than one question incorrectly after five intraverbal probe sessions, an additional element was added to the listener training, during which the participant was required to tact the item while touching it. An echoic prompt was used to evoke the tact. Following mastery of this stage, the intraverbal probe session was conducted and was identical to that described above.

Untaught Control Questions

Completion of listener training and intraverbal probes was immediately followed by probes of the two untaught control questions. These tests were identical to baseline.

Design

A nonconcurrent multiple-baseline design across participants was used to evaluate the independent variable. The participants were randomly assigned to a 2- or a 3-week baseline. Two untaught control questions were included for each participant in baseline and intraverbal probe conditions.

Results

As shown in Fig. 1, none of the participants answered the eight questions correctly during baseline. After mastery of the listener responses, four of five participants demonstrated mastery or near-mastery levels in the intraverbal probes (i.e., emergence).

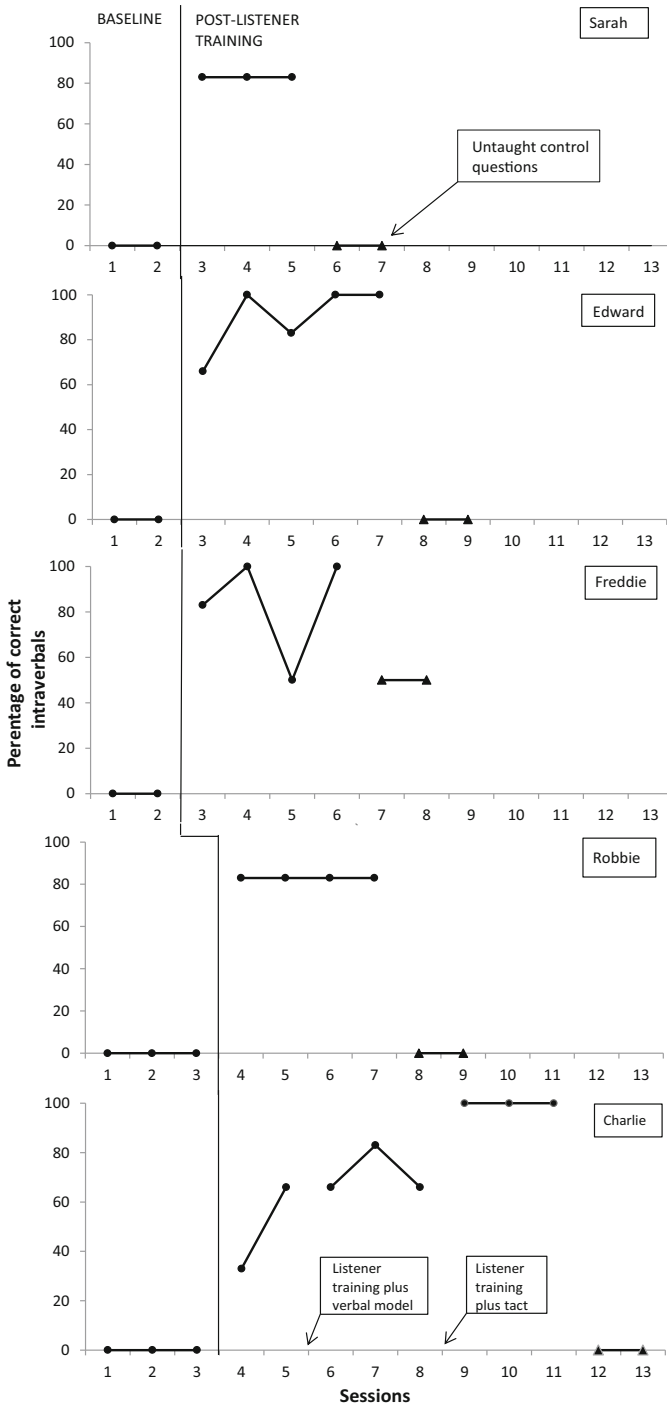


Fig. 1 Percentage of correct intraverbals before and after listener training across participants. Responses to two untaught control questions are depicted with triangular data points

Table 4 Number of listener training trials and subsequent intraverbal probes

Participant	Training and probe trials
Sarah	115 training trials-probe-probe-probe
Edward	428 training trials-probe-174 training trials-probe-probe-probe-probe
Freddie	127 training trials-probe-probe-117 training trials-probe-probe-probe
Robbie	158 training trials-probe-112 training trials-probe-probe-probe
Charlie	374 training trials-probe-104 training trials-probe (standard listener training) 120 training trials-probe-87 training trials-probe-78 training trials (listener training + vocal model) 405 training trials-probe-probe-probe (listener training + tact)

One participant (Charlie) required additional teaching that included tact training during listener training. In addition, four of the five participants responded incorrectly to the two untaught control questions, and one participant (Freddie) responded correctly to one of the two control questions (i.e., 50 % correct). Such low performance strengthens the prior demonstration of functional control in the multiple-baseline design.

Table 4 shows the number of listener training trials and the sequence of intraverbal probes for each participant. As can be seen in Fig. 1 and Table 4, emergence of the intraverbal form occurred for five out of six questions immediately following listener training for Robbie and Sarah. Subsequent listener training sessions between intraverbal probes (two for Sarah, three for Robbie) did not result in further emergence, and one question remained incorrect for each participant.

Emergence of the intraverbal form also occurred for five out of six questions following listener training for Freddie. On the second probe—after reintroduction of listener training—this increased to six out of six questions correct. However, on the third intraverbal probe, this decreased to three questions correct, but returned to six questions correct on the subsequent intraverbal probe.

Edward initially answered four of the six questions correctly, but on the subsequent four probes he answered six, five, six, and six questions correctly, respectively. On the first and second intraverbal probe sessions, emergence of the intraverbal form occurred for two and four out of the six questions, respectively, for Charlie. This was virtually unchanged after the verbal model was added to the listener training, but after one session of listener training with tacting, all six questions emerged in the intraverbal form on the three remaining intraverbal probe sessions.

Discussion

The present study evaluated the emergence of intraverbal responses following listener training in five children with autism. The target emergent intraverbal behavior was to answer questions, such as answering “tomato” when asked, “What do you eat that is red?” Listener training consisted of teaching participants to select the object tomato when hearing, “What do you eat that is red?” Results showed that four out of five participants demonstrated the emergence of intraverbal responses following listener training.

There are perhaps two important reasons why listener training was successful for these participants. First, the antecedent stimulus for the emergent intraverbal response was identical to the antecedent stimulus during listener training. Only the response form differed between training and testing: the response form during listener training was a stimulus-selection response (i.e., touching the correct picture), and the response form during the intraverbal probe sessions was vocal. Second, all participants' educational provision included programs to teach listener behavior, echoics, tacts, and intraverbals, and the participants could tact all stimuli as well as respond to them with listener behavior (Coon & Miguel, 2012; but see Petursdottir et al., 2014). Neither of these variables were included in previous research, and the effect of these two reasons on the emergence of intraverbal behavior may be addressed in future research.

A tact prompt was ultimately successful for the participant for whom emergence of the intraverbal did not occur (Charlie). However, concurrently with the tact prompt, an echoic prompt was provided. Hence, it cannot be determined whether Charlie acquired the intraverbal response because of the echoic prompt, the tact prompt, or a combination of the two.

Some limitations of the present study should be considered. During probing, continuous reinforcement (i.e., praise) was used. Hence, the results obtained could have been due partly to direct reinforcement and not only to the listener training. Notably, however, intraverbal responses were not reinforced until they had emerged for the first time in the absence of any prompts. Hence, the reinforcement contingency may be more relevant for the maintenance of the intraverbals that had emerged as a result of the listener training rather than for establishing them. Future research could explore whether probing under extinction or probing using a noncontingent reinforcement schedule would more clearly isolate the effects of the listener training. In clinical practice, however, the use of extinction and noncontingent reinforcement may not be optimal (Grow & Kodak, 2010).

A detailed analysis of the stimulus control exerted by all parts of the verbal antecedents was not conducted in this study. Participants were asked questions in which only one part of the antecedent stimulus may have exerted stimulus control over the response. For example, Freddie was asked: "What's a food that's yellow?" but no other question was asked that included "food" (e.g., "What's a food that's green?") or "yellow" (e.g., "What's an animal that's yellow?"). It may be the case that his response "banana" was under the control of only the word "food" or only the word "yellow" in the antecedent stimulus (Grow & LeBlanc, 2013). Future research could examine whether participants could answer questions with novel, untrained stimuli. For example, following successfully learning to answer the question: "What food is yellow?" with the answer: "banana," would participants transfer this skill to answering "lemon," either with or without visual stimuli present and without further training? Also, future studies may compare efficacy of listener training to tact training and/or echoic training in the acquisition of intraverbal responses, to determine which procedure, if any, is more effective.

A potential benefit of using listener training to establish intraverbal behavior is that a listener repertoire is established concurrently with the intraverbal repertoire. If, in contrast, children learn to answer questions only in response to specific verbal antecedents (e.g., to learn to always say "banana" when asked, "What food is yellow?") then the correct verbal response "banana" may occur without listener behavior. That is,

the participant may say “banana” in response to hearing the question “What food is yellow?” without being able to identify the object banana when hearing “touch banana” (cf., Ingvarsson, Cammilleri, & Macias, 2012). This may particularly be the case if echoic prompts are used because there is no object or picture present when the intraverbal response is reinforced.

The type of questions used in this study varied within each participant. For example, the intraverbals taught to Charlie included category-color compounds (e.g., “What’s an animal that’s grey?”), category-verb compounds (e.g., “what’s an animal that flies?”), and verb-shape compounds (e.g., “What do you kick that’s round?”). The untaught control intraverbals were different again (see Table 1). Research could examine whether listener training of several intraverbals within the same class (e.g., category-color compounds, such as “What’s an animal that’s brown?”, “What’s an animal that’s grey?” and “What’s an animal that’s black and white?”) may result in correct responses to novel intraverbals within the same class. Further, research could examine whether participants may learn to give multiple, novel answers to the same question (e.g., answer “broccoli,” “asparagus,” and “cucumber” in response to the question “What’s a vegetable that’s green?”) through training multiple exemplars at the listener training stage and probing for novel answers at the intraverbal stage. This may yield important information for teachers who can then provide more effective instruction to children with autism.

Compliance with Ethical Standards No funding was received towards the completion of this study.

Ethical Approval All procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants involved in the study.

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