



## A Comparison of Teaching Intraverbal-Tact and Listener Relations to Children Diagnosed with Autism Spectrum Disorder

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**ABSTRACT** – Studies using teaching techniques derived from Applied Behavior Analysis (ABA) principles have shown promising results, based on empirical evidence, in teaching speaker and listener behavior to individuals diagnosed with Autism Spectrum Disorder (ASD). Our objective was to compare the effects of two teaching procedures on the acquisition of intraverbal-tact and listener relations involving spatial relations concerning body parts in six boys with autism. In “intraverbal-tact-to-listener”, questions in the presence of non-verbal stimulus were taught and then tested for emergence of listener responding. In “listener-to-intraverbal-tact”, listener responses were initially taught and the emergence of intraverbal-tact responses were tested. An alternate treatment design with an embedded nonconcurrent multiple baseline design across participants was used. The results suggest that the intraverbal-tact-to-listener protocol was more effective. Such data concerning to body parts spatial relations replicate findings for other repertoires.

**KEYWORDS:** Verbal Behavior, Intraverbal-tact, Listener Responses, Autism Spectrum Disorder

## Uma Comparação do Ensino de Relações de Tato-Intraverbal e de Ouvinte para Crianças Diagnosticadas com Transtorno do Espectro do Autismo

**RESUMO** – Estudos utilizando técnicas de ensino derivadas dos princípios da Análise do Comportamento Aplicada (ABA) têm mostrado resultados promissores, baseados em evidências empíricas, no ensino de comportamento de falante e de ouvinte para indivíduos com diagnóstico de Transtorno do Espectro do Autismo (TEA). Nosso objetivo foi comparar os efeitos de dois procedimentos de ensino na aquisição de tato-intraverbal e de relações de ouvinte envolvendo relações espaciais para partes do corpo em seis meninos com TEA. No “tato-intraverbal-para-ouvinte”, perguntas na presença de estímulos não verbais foram ensinadas e então testadas para o surgimento de respostas de ouvinte. No “ouvinte-para-tato-intraverbal”, as respostas de ouvinte foram inicialmente ensinadas e a emergência de respostas de tato-intraverbais foram testadas. Foi usado um delineamento de tratamento alternado acoplado a um delineamento de linha de base múltipla não simultânea entre os participantes. Os resultados sugerem que o protocolo “tato-intraverbal-para-ouvinte” foi mais eficaz. Esses dados relativos às relações espaciais das partes do corpo replicam achados para outros repertórios.

**PALAVRAS-CHAVE:** Comportamento Verbal, Tato, Intraverbal, Respostas do Ouvinte, Transtorno do Espectro do Autismo

Individuals diagnosed with Autism Spectrum Disorder (ASD) often show deficits of verbal repertoire. A significant percentage of those individuals show little or no functional speech, making it difficult to participate in educational, social, leisure, and labor environments (Lorah, Tincani, & Parnell, 2019).

Studies using teaching techniques derived from Applied Behavior Analysis (ABA) principles have shown promising results, based on empirical evidence, in teaching speaker and listener behavior to individuals with ASD (Eikeseth, Smith, Jahr, & Eldevik, 2002; Howard et al., 2014; Sundberg & Partington, 1998). In his discussions of verbal behavior

acquisition, Skinner (1957) states that speaker and listener's behaviors are distinct operants that initially require direct and separate teaching, even though they may become related after the acquisition of such eventually interrelated repertoires.

The proposed independence in the acquisition of such operants (Skinner, 1957), and the possibility that certain variables could facilitate the emergence of one operant after learning the other, increase research interest on sequence of teaching involving speaker and listener's repertoires. Petursdottir and Carr (2011) reviewed the literature on instructional sequence recommendations for teaching verbal repertoire for individuals with ASD. They concluded that teaching speaker's repertoires is more effective for the emergence of listener's repertoires than the other way around. However, the authors mention the need of further research comparing the effectiveness of speaker and listener's response training in the emergence of untrained responses in individuals with ASD. Another issue raised by Petursdottir and Carr (2011) is the prevalence of studies that used the tact operant and selection responses (in the context of conditional discrimination trials), indicating the relevance of investigating the acquisition of such verbal operants via other teaching strategies.

In this sense, Kodak and Paden (2015) conducted a three-step study with two three- and four-year-old children diagnosed with ASD. The objective was to compare the acquisition of intraverbal and listener behaviors by feature, function, and stimulus class (FFC). Tact responses were also measured during listener's response training to assess whether higher levels of tact responses would predict the emergence of intraverbal behavior after training. Regarding the number of sessions, less training was required to reach mastery criteria in intraverbal training than in listener training by FFC. In addition, intraverbal training consistently produced emergent listener behavior. In comparison, FFC listener training did not consistently lead to the emergence of intraverbal behavior.

Still in this line of research, Bao et al. (2017) used an alternate treatment design to compare the effects of three instructional sequences to teach stimulus relations and responses by FFC to three children diagnosed with ASD: (a) listener-to-speaker, (b) speaker-to-listener, and (c) mixed. The authors suggest that the speaker-to-listener training sequence was more efficient for the three participants. Additionally, this sequence resulted in more untrained emerging listener responses. Kodak and Paden (2015), Bao et al. (2017) and Petursdottir and Carr (2011)'s findings suggest that teaching speaker repertoires is more efficient for the emergence of listener repertoires than otherwise.

Silva and Elias (2018) verified the effects of teaching listener responses to left/right spatial relations involving body parts in the emergence of new listener responses in two experiments using Multiple Exemplar Training (MET) and prompt fading. LaFrance and Tarbox (2019, p. 3) state that "MET can involve the presentation of stimuli depicting the same teaching target in different formats" and that "behaviors

acquired through MET are described as responses that have come under the control of stimulus features present in the exemplars used during training". In Silva and Elias (2018), the targets were the spatial relations left and right for many exemplars. Training involved actions with body parts and spatial relations ("Raise right/left arm", "Touch right/left ear", "Show right/left hand", "Raise right/left leg"); after reaching mastery criteria, actions involving objects and spatial relations were tested ("Sit in the right/left chair", "Raise the right/left card", "Take the right/left toy car"). Participants of the first experiment were a nine-year-old boy diagnosed with ASD and two sixteen-year-old boys with intellectual disabilities and a single-subject A-B design was used. Participants of the second experiment were four 10-to-12-year-old boys diagnosed with ASD. A multiple baseline design across participants was used. Overall, the results indicated learning of listener responses involving body parts and right/left spatial relations and the listener response generalization for objects.

Silva and Elias's (2018) findings suggest that participants with ASD learn and generalize listener responses for left and right spatial relations involving body parts and objects. However, there is a gap in the literature regarding the greater effectiveness of teaching speaker repertoire in order to obtain the emergence of listener repertoire or vice-versa with respect to intraverbal-tact and listener responses for spatial relations and body parts. Some studies that used spatial relations such as front/back, on/under and right/left (Alves & Ribeiro, 2007; Lee, 1981; Luke et al., 2011; Medeiros & Bernardes, 2009) did not teach or test such relations involving body parts and did not check generalization for novel relations.

According to Skinner (1957), in an intraverbal relation, the verbal response is controlled by a verbal stimulus and generalized reinforcers and has no point-to-point correspondence with the stimulus. Therefore, intraverbal behavior is largely involved in verbal interaction between humans, such as in conversation, answering questions and solving problems (Sundberg & Sundberg, 2011). Thus, one can say that part of the social interactions between people involves intraverbal responses, making this a repertoire that could be present in teaching programs for people with ASD, who present deficits in communication and social interaction. An intraverbal-tact response refers to an intraverbal response in the presence of a non-verbal stimulus. A simple example is saying "Left" when someone asks "Which arm do I wear the watch on?" and, simultaneously, shows the left arm.

Given this scenario, the aim of this study was to compare, under controlled conditions, the effects of intraverbal-tact response teaching on the emergence of listener responses (intraverbal-tact-to-listener teaching protocol) with the effects of listener response teaching on the emergence of intraverbal-tact responses (listener-to-intraverbal-tact teaching protocol) for body parts and left/right or front/back spatial relations in six six-to-12-year-old boys with ASD. Additionally, the generalization of such repertoires to objects was verified.

## METHOD

*Participants.* Participants were six boys (P1, P2, P3, P4, P5, and P6) diagnosed with ASD (all with ICD – 84.0, classic autism). All participants were vocal and, according to individual reports obtained at the institutions and first author’s observations, followed instructions composed of one step, presented tact repertoires with up to two words and answered some everyday questions (intraverbal). The six participants had motor imitation and echoic repertoires according to the results of the implementation of the protocols created for this study (description below).

P1 and P2 were six, P3 was 10, P5 and P6 were 11 and P4, 12 years old. P1, P2, P3, P5 and P6 were in the process of literacy; P4 was literate, P1 presented difficulties with word pronunciation and sentence formation; P3, P5 and P6 had difficulties in learning to read and write; P5 had no understandable verbal-vocal repertoire; and P4 showed deficit in motor skills and difficulties with writing. P1 and P2 attended regular school and received behavioral intervention two hours a week; P3, P4, P5 and P6 attended only a specialized institution. Two participants (P2 and P5) showed crying or tantrum behavior when they had difficulty following demands related to novel tasks; the other four participants did not have any behavioral problems that could be a barrier to participate in this study. The inclusion criterion was that the participant presented at least 80% of correct responses in the motor imitation and echoic repertoire test (description below) and a maximum of 40% of correct responses in each intraverbal-tact and listener responses pretest (description below). Motor imitation and echoic responses were used as prompts in teaching phases.

*Setting.* P1 and P2 were part of an ABA service and research on learning and development project, where the rooms were air-conditioned, with natural and artificial lighting, child-sized tables and chairs, bookshelves and mats. P3, P4, P5, and P6 attended an Autism Service Center, where the room contained a door and a window, a wall fan, a large desk, a small school desk, a closet, two standard-size chairs, and two child-sized chairs.

*Equipment and Materials.* With P1 and P2 a camcorder (Sony DCR-RX22) was used to record teaching and

testing sessions. Toys and mobile phone games were used as consequences for appropriate responses. For the other participants, a notebook (DELL Inspiron 14 3000 series) presented video clips as consequences for correct responses, a mobile phone (Samsung Galaxy A5 / 2017 model SM-A520F) and a holder was used to record the sessions. Other materials were: two identical toy cars, two chairs and a table (for generalization tests).

*Experimental Design.* An alternate treatment design with an embedded nonconcurrent multiple baseline design across participants was used to compare the effects of “intraverbal-tact-to-listener” and “listener-to-intraverbal-tact” training. Thus, the listener and intraverbal-tact repertoires were measured in pre and posttests in a single subject fashion.

*Experimental Condition Sequence.* Initially, participants responded to the motor imitation and echoic response probes. They were then exposed to the initial listener and intraverbal-tact response baseline testing sessions with all spatial relations (left/right, front/back) related to body parts and objects, according to the experimental design. Then, participants were randomly distributed in two distinct groups. Half of the participants were exposed to right/left intraverbal-tact responses and front/back listener responses teaching; the other half was exposed to front/back intraverbal-tact responses and right/left listener responses teaching. Intraverbal-tact and listener responses were taught interspersed in the same sessions, in a way that the programmed number of trials for intraverbal-tact and for listener responses was the same. After reaching mastery criteria for both repertoires, participants were exposed to posttests of the relations not directly taught. All sessions were carried out individually with each participant. Table 1 presents taught and tested repertoires for each participant, remembering that all relations were pre-tested.

## Procedure

*Motor Imitation Probe.* Motor imitation was tested individually through discrete trials that began with the verbal instruction “Do it” and a movement performed by the

Table 1  
Taught and tested repertoires for each participant.

Participants	Teaching		Post-test / Generalization	
	Listener	Intraverbal-tact	Listener	Intraverbal-tact
P1	Right/left	Front/back	-	-
P3	Right/left	Front/back	Front/back	Right/left
P4	Right/left	Front/back	Front/back	Right/left
P2	Front/back	Right/left	Right/left	Front/back
P5	Front/back	Right/left	Right/left	Front/back
P6	Front/back	Right/left	Right/left	Front/back

experimenter. The movements were: touching nose, clapping hands, raising arms, touching ears, sitting in a chair, raising one leg and the other in alternation, looking back and forth turning the head, placing hands on the knees, getting up from chair, and walking around the chair. Responses were considered correct when the participant imitated the action performed by the experimenter initiating the response within 10s (as used in Silva & Elias, 2018). Other responses were considered incorrect. Correct responses were followed by descriptive praise (for example, “Ok, you touched your nose!”); incorrect responses were followed by a 5-second intertrial interval and the presentation of the next trial. This probe consisted of a single 10-trial block.

*Echoic Probe.* The echoic repertoire was tested individually through discrete trials that began with the verbal instruction “Say” followed by distinct Portuguese words or pseudo words with two or three syllables. The Portuguese words were *cano*, *vala*, *papiro*, *mesada*, and *pintura*; the pseudo words were *pora*, *bero*, *difo*, *benego*, and *vicajo*. Responses were considered correct when the participant correctly repeated all the phonemes of the word dictated by the experimenter within 10s. Other responses were considered incorrect. Correct responses were followed by descriptive praise (for example, “Good, you said *cano*!”); incorrect responses were followed by a 5-second intertrial interval and the presentation of the next trial. This probe consisted of a single 10-trial block.

*Preference Assessment.* Participants’ parents, service project supervisor, and service center teachers were asked to point out items (toys or videos) preferred by the participants. A multiple stimulus without replacement preference assessment was then conducted, according to Carr, Nicolson, and Higbee (2000), with three presentations of all stimuli, obtaining a preference hierarchy. If another toy or video was requested, or the child lost interest in the item chosen during the session, the multiple stimulus without replacement preference assessment was conducted again, with all items except those already chosen. Higher preferred items were used as consequences for correct responses in the teaching phases. For P1 and P2, six to twelve toys were presented at the beginning of each session, followed by the instruction “Choose one”. Contingent on choosing, the participant had access to the item for 15 seconds. For P3, P4, P5, and P6, six video clips were simultaneously displayed for a few seconds at the beginning of each session on a notebook screen, using software designed by the second author for this purpose, followed by the instruction “Choose one”. The video chosen was paused during the demands and presented for 15 seconds as a consequence for correct responses.

*Listener Repertoire Test.* Each trial started with the participant in front of the experimenter. After getting participant’s attention, the experimenter provided an instruction identifying an action, an object or a body part, and the spatial relation. The following instructions were presented (the instructions are presented in Portuguese

followed by the translation to English to illustrate instruction patterns in the original language, such as “frente” for front or forward and “trás” for back or behind): “Levante o braço esquerdo” (Raise your left arm), “Toque a orelha direita” (Touch your right ear), “Levante a perna direita” (Raise your right leg), “Toque a orelha esquerda” (Touch your left ear), “Levante o braço direito” (Raise your right arm), “Mostre a mão direita” (Show your right hand), “Levante a perna esquerda” (Raise your left leg), “Mostre a mão esquerda” (Show your left hand), “Sente na cadeira da esquerda” (Sit on the left chair), “Pegue o carrinho da esquerda” (Take the left toy car), “Sente na cadeira da direita” (Sit on the right chair), “Pegue o carrinho da direita” (Take the right toy car), “Coloque os braços para frente” (Put your arms forward), “Toque atrás das orelhas” (Touch behind the ears), “Coloque as mãos para frente” (Put your hands forward), “Coloque um pé para trás” (Put one foot backward), “Toque a frente das orelhas” (Touch the front of your ears), “Coloque os braços para trás” (Put your arms back), “Coloque um pé para frente” (Put one foot forward), “Coloque as mãos para trás” (Put your hands behind you), “Fique na frente da cadeira” (Stand in front of the chair), “Fique atrás da cadeira” (Stand behind the chair), “Fique na frente do carrinho” (Stand in front of the toy car), “Fique atrás do carrinho” (Stand behind the toy car). Responses were considered correct if the participant performed the requested action within 10 seconds. Other responses were considered incorrect. There were no differential consequences for correct and incorrect responses. These instructions were presented in such a way that the same body part or object and spatial relations were not presented in consecutive trials.

*Intraverbal-tact Repertoire Test.* Each trial started with the participant in front of the experimenter. After getting participant’s attention, the experimenter presented a question, which had as possible responses “left”, “right”, “front” or “back” (the intraverbal component), while pointing to a part of the participant’s body or to a material (the tact component). For front/back relations, the experimenter made an action (for example, she put one foot back) and asked the participant to imitate her before presenting the question. The following questions were presented for right/left responses: “Que braço é esse?” (Which arm is this?), “Que perna é essa?” (Which leg is this?), “Que orelha é essa?” (Which ear is this?), “Que mão é essa?” (Which hand is this?), “De que lado está o carrinho?” (Which side is the toy car on?), “De que lado está a cadeira?” (Which side is the chair on?). The following questions or incomplete phrases were presented for front/back responses: “Os braços estão para ...” (The arms are to the...), “As mãos estão para ...” (The hands are to the...), “O pé está para...” (The foot is to the...), “As mãos estão em frente ou atrás das orelhas?” (Are the hands in front of or behind the ears?), “Você está em frente ou atrás da cadeira?” (Are you in front or behind the chair?), “Você está em frente ou atrás do carrinho?” (Are you in front or behind the toy car?). Responses were considered correct



if the participant said the correct side/location within 10s. Other responses were considered incorrect. There were no differential consequences for correct and incorrect responses. These questions were presented in such a way that the same body part or object and spatial relation were not presented in consecutive trials.

*Listener Repertoire Teaching.* Each teaching trial started with the participant in front of the experimenter. After getting participant's attention, the experimenter provided an instruction (for example, "Raise your right arm" or "Put your arms forward"). Responses were considered correct when the participant performed the action within 10 seconds and were followed by verbal praise and delivery of the most preferred item (toys or videos). Other responses were considered incorrect. Incorrect responses were followed by a three-step correction procedure, which contained (i) trials with full physical prompt, (ii) trials with partial physical prompt (pointing or touching the body part), and (iii) trials with imitation prompt (for example, after the instruction "Raise your right arm", the action was performed simultaneously by the experimenter, as a mirror image, so that the participant could imitate her), in that order. The participant moved from one prompt to the other only when he performed the correct response (for example, partial physical prompt trials were conducted until the participant showed a correct response; then, the next trial would be presented with the imitation prompt). After showing a correct response with the imitation prompt, a new trial was presented only with verbal instruction. After an independent correct response, which is a response controlled by verbal instruction (without prompt), the same procedure was performed for another instruction (for example, "Raise your left leg" or "Put one foot back"). Each of the eight instructions was individually presented until the same criteria were reached for each action. For the individual actions, there was no predetermined number of trials in a teaching block, which ended according to participant's availability. The next step was conducting sessions comprising all eight actions interspersed in one block. The final criterion for this phase was at least seven independent correct responses (87.5%, which corresponds to a single incorrect response) in a same eight-trial block. P1, P3, and P4 were taught the actions: "Raise the left arm", "Raise the right arm", "Touch the left ear", "Touch the right ear", "Raise the left leg", "Raise the right leg", "Show left hand", "Show right hand". P2, P5 and P6 were taught the actions: "Put your arms forward", "Put your arms behind you", "Touch the front of your ears", "Touch behind your ears", "Put your hands forward", "Put your hands behind you", "Put one foot forward", "Put one foot backwards".

*Intraverbal-tact Repertoire Teaching.* The participant was taught to say two spatial relations (left/right or front/back) after the experimenter presented a question regarding a body part. Each teaching trial started with the participant in front of the experimenter. For left/right relations, after getting participant's attention, the experimenter pointed to

a part of the participant's body and asked a question (e.g., "What arm is this?"). For front/back relations, after getting participant's attention, the experimenter made a move (e.g., she put one foot back) and asked the participant to imitate her; then, she pointed to that part of the participant's body and presented a question or incomplete phrase (for example, "The foot is to the..."). Responses were considered correct when the participant said the corresponding spatial relation within 10s and were followed by verbal praise and access to a preferred item. Other responses were considered incorrect. Incorrect responses were followed by a correction procedure that consists of providing echoic prompt on the next trial (for example, after asking "Which arm is this?" and pointing to the participant's left arm, the correct response "Left" was immediately given to the participant to echo). The echoic prompt was always performed in three steps, in the following order: immediate prompt with the complete word; immediate prompt with the beginning of the word; and immediate prompt similar to the previous one with a lower voice volume. The participant moved from one prompt to the other only when he performed the correct response (for example, immediate prompt with the complete word trials were conducted until the participant showed a correct response; then, the next trial would be presented with immediate prompt with the beginning of the word). After showing a correct response with the prompt in a lower voice volume, a new trial was presented only with verbal instruction. After these three trials, a new one was presented only with the question. The mastery criterion for this phase was an independent response (with no echoic prompt). Then the same procedure was performed for another question. There was no predetermined number of trials for each block that ended according to participant's availability. After reaching the same criterion of an independent response for each question individually, the next session consisted of a block with the eight questions presented interspersedly. The final mastery criterion for this phase was at least seven independent correct responses (87.5%, which corresponds to a single incorrect response) in the same eight-trial block. For P1, P3 and P4 the following questions were presented: "Which arm is this?", "Which leg is this?", "Which ear is this?" and "What hand is this?". For P2, P5, and P6 the following incomplete phrases or questions were presented: "The arms are to the...", "The hands are to the...?", "The foot is to the...?", "Are the hands in front or behind your ears?".

*Mixed Criterion.* Both response classes (listener and intraverbal-tacts) would continue to be trained even if in one of them the participant reached the criterion before the other. A maximum number of trial blocks was not established to reach the criterion.

*Posttest.* The same procedure as described for baseline listener and intraverbal-tact tests with body parts was implemented. The posttests focused the alternative operant considering teaching phase, as follows: For actions that were taught as listener responses, the posttest evaluated intraverbal-tact responses for the same spatial relation;

for actions that were taught as intraverbal-tact responses, listener responses were tested for the same spatial relation (see Table 1). There were no differential consequences for correct and incorrect responses. A maximum of two posttest sessions were applied.

*Generalization trials.* Questions or instructions with objects (which were not part of the teaching phases), as listed in the baseline tests, served to verify generalization. The following instructions were presented for listener responses: “Sit in the left chair”, “Take the left toy car”, “Sit in the right chair”, “Take the right toy car”, “Stand in front of the chair”, “Stand behind the chair”, “Stand in front of the toy car”, “Stand behind the toy car”. For right/left responses, two toy cars on a table or two chairs on the floor were in front of the participant. For front/back responses, one toy car on a table or one chair on the floor was on the participant’s left side. The following questions were presented for intraverbal-tact responses: “Which side is the toy car on?”, “Which side is the chair on?”, “Are you in front or behind the chair?”, “Are you in front or behind the toy car?”. For these questions, the participant was placed right, left, in front of or behind the

objects (the toy car was on a table and the chair on the floor). A maximum of two generalization sessions were applied.

*Interobserver agreement and procedural integrity.* All sessions were video recorded. A second observer observed the videos and implemented the data recording procedures for 30% of the sessions. Interobserver agreement (IOA) was calculated on a trial-by-trial basis by dividing the number of trials in agreement by the total number of trials in agreement plus the number of trials in disagreement and then multiplying by 100. IOA was 100% across all conditions for each participant. In addition, the procedural integrity was also verified, in which the experimenter’s behavior in the correct procedure application was evaluated by an observer who filled out a checklist of such behaviors for 40% of the sessions divided equally in all experimental phases. The form was completed for each trial, indicating whether the instruction and materials were correctly presented, the absence of unscheduled prompts, and the intertrial interval. The results indicated that the experimenter performed 94% of the trials according to the procedure for P1, 92% for P2, 90% for P3, 85% for P4, 87% for P5 and 90% for P6.

## RESULTS

All participants presented 100% correct responses to the motor imitation and echoic probes. This indicates that the participants already had an imitation repertoire and responded under verbal instruction control. Figure 1 presents the results of P1 and P2, and Figure 2 presents the results of P3, P4, P5, and P6 for the experimental procedure. This division was made according to the place and period in which each participant underwent the procedure. As shown in Figures 1 and 2, all participants showed emergence of novel intraverbal-tact and listener responses.

Four (P2, P3, P5, and P6) of the five (P2, P3, P4, P5, and P6) participants who completed the procedure met the mastery criterion for the intraverbal-tact responses in fewer sessions. Three (P3, P5 and P6) of the five had more correct responses in the posttest for listener responses and one (P2) presented the same results in the posttest and, finally, in generalization trials, three participants (P4, P5 and P6) presented more correct listener responses. Additionally, only one participant (P6) reached 100% correct responses in the listener posttest and none in the intraverbal-tact posttest and three (P4, P5, and P6) reached 100% correct responses in generalization trials for listener responses and none for intraverbal-tact responses. P1 did not meet the criterion of 100% correct responses in twenty-four sessions until the end of the school year. Nevertheless, P1 data indicate that the percentages of correct intraverbal-tact responses were above the average for listener responses.

P2 reached mastery criterion for intraverbal-tact responses (right/left) in the second session and for listener responses (front/back) in the sixth session. In the posttest, P2 achieved

88% correct responses for both listener (right/left) and intraverbal-tact (front/back) responses. In generalization trials, P2 achieved 83% correct responses for right/left intraverbal-tact responses and 50% for front/back listener responses.

P3 reached mastery criterion for intraverbal-tact responses (front/back) in the eleventh session and for listener responses (right/left) in the twelfth session, and the percentage of correct responses was generally higher for intraverbal-tact responses. In the posttest, P3 achieved 50 and 71% correct intraverbal-tact responses (right/left) and 64 and 71% correct listener responses (front/back). In generalization trials, P3 achieved 50 and 83% correct right/left intraverbal-tact responses and 17 and 50% correct front/back listener responses.

P4 reached mastery criterion for both intraverbal-tact (front/back) and listener (right/left) responses in the fourth session. P4 was the only participant for whom the percentage of correct responses was generally higher for listener trials during teaching phases. In the posttests, P4 reached 64 and 100% correct intraverbal-tact responses (right/left) and 50 and 43% correct listener responses (front/back) in two sessions. In generalization trials, P4 showed 17% correct right/left intraverbal-tact responses in two sessions and 33 and 100% correct front/back listener responses.

P5 reached mastery criterion for intraverbal-tact (right/left) responses in the eighth session and for listener responses (front/back) in the sixth session, but in subsequent sessions performance dropped from 100% to 72%, again meeting the criterion in the ninth session. In the last four teaching sessions, the percentage of correct intraverbal-tact responses

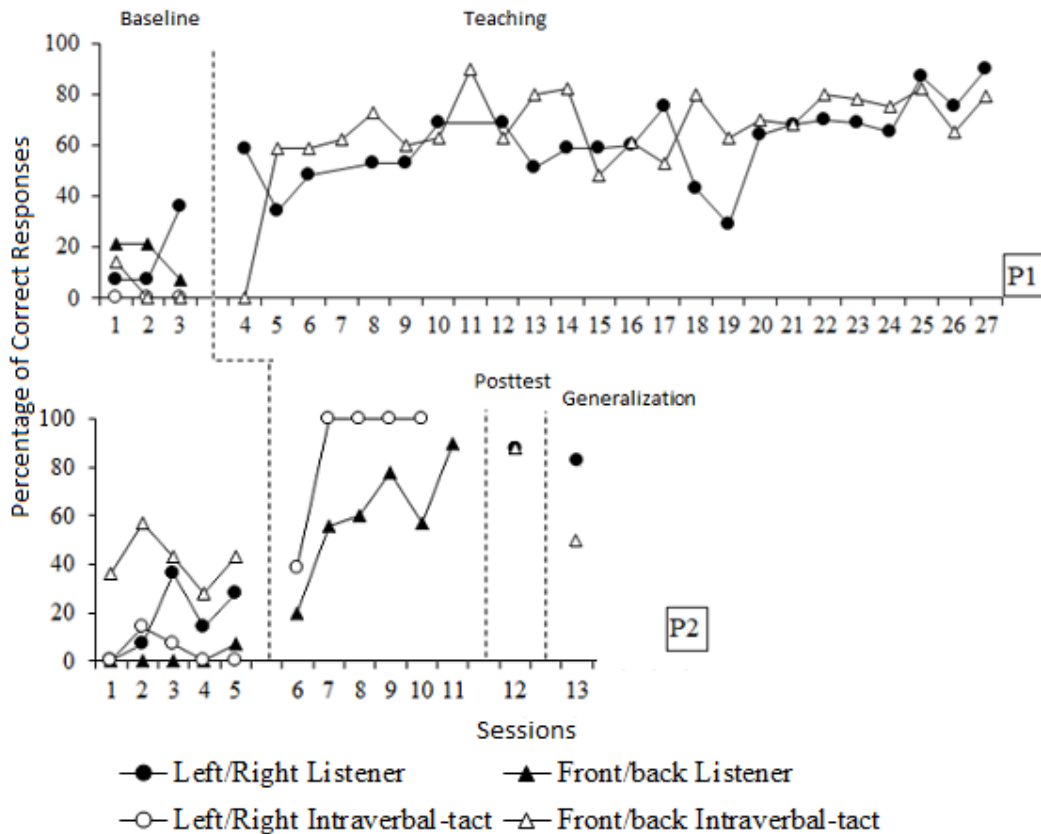


Figure 1. P1 and P2 performances throughout the procedure. Vertical dotted lines indicate experimental condition changing.

was higher than the one's for listener. In the posttests, P5 achieved 57 and 86% correct front/back intraverbal-tact responses and 79 and 86% correct right/left listener responses in two sessions. In generalization trials, P5 achieved 50 and 83% correct front/back intraverbal-tact responses and 100% correct right/left listener responses in two sessions.

P6 reached mastery criterion for intraverbal-tact responses (right/left) in the seventh session and for listener responses

(front/back) in the tenth session. The percentage of correct responses, in general, was higher for the intraverbal-tact ones. In the posttests, P6 achieved 64 and 71% correct front/back intraverbal-tact responses and 100% correct right/left listener responses in two sessions. In generalization trials, P6 showed 33 and 50% correct front/back intraverbal-tact responses and 100% correct right/left listener responses in two sessions.

## DISCUSSION

This study alternated teaching trials of listener and posttest of intraverbal-tact responses with teaching intraverbal-tact and posttest of listener responses. For each type of teaching, we used different stimuli (MET). Overall, the results suggest that teaching intraverbal-tact responses produced better posttest and generalization performances for listener responses than listener responses produced intraverbal-tact responses, corroborating and extending to new repertoires what is proposed by Petursdottir and Carr (2011), Sprinkle and Miguel (2012), Kodak and Paden (2015) and Bao et al. (2017). Additionally, in general, participants had a greater number of correct intraverbal-tact than listener responses during teaching sessions.

Although the results favor the “intraverbal-tact-to-listener” protocol, one may argue that, as the participants were required to engage in a movement identical to the listener response prior to the presentation of the antecedent verbal stimulus during intraverbal-tact training, it might be more probable that the listener response will emerge as a result of the intraverbal-tact training. Thus, due to this difference across training procedures, one would expect that the intraverbal-tact training was set up to increase the likelihood of emergence in comparison to the listener training. However, it is only true for “front/back” spatial relations. By taking “left/right” spatial relations, where no imitation was required and which results also indicate the

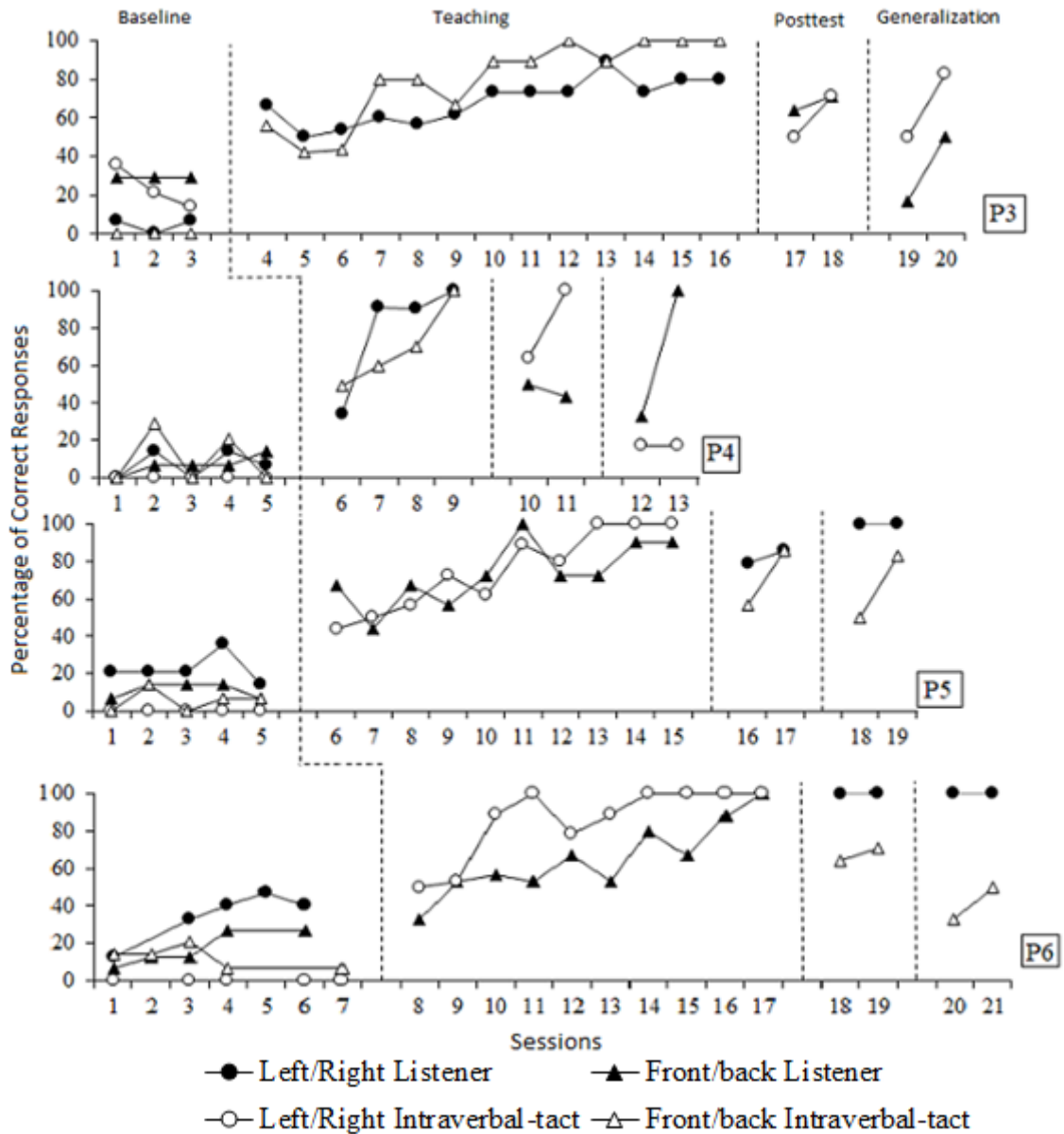


Figure 2. P3, P4, P5 and P6 performances throughout the procedure. Vertical dotted lines indicate changing experimental condition.

“intraverbal-tact-to-listener” protocol as producing better results, this argumentation seems not to be valid.

It is also possible that “listener-to-intraverbal-tact” teaching is often less efficient because, in its contingency arrangement, the vocal response that will be later required is not required throughout the training. The vocal response may or may not occur as an echoic response during listener teaching, but the teaching contingencies do not require it and do not even reinforce it differently when they occur. The importance of the vocal response (in this case, an echoic) in “intraverbal-tact-to-listener” productivity and vice versa has already been highlighted by Horne and Lowe (1996 – see also Greer & Keohane, 2006; Greer & Longano, 2010) in the context of the proposition of integration between speaker

and listener repertoires (naming). Further studies could investigate whether the requirement for an echoic response in listener training (within the “listener-to-intraverbal-tact” procedure) could reduce the difference in efficiency between this type of training and the “intraverbal-tact-to-listener” one, with teaching procedures similar to the ones described here. Few studies have explored the effects of echoic response requirements in the context of this training type and “listener-to-intraverbal-tact” productivity test (Hawkins, Kingsdorf, Charnock, Szabo, & Gautreaux, 2009; Olaff, Ona, & Holth, 2017).

Another possible advantage of the intraverbal-tact teaching procedure is that the responses had two or three antecedent controls: the question itself (e.g., “What arm is



this?”), a nonverbal stimulus that characterizes a tact (in this example, the pointed arm) and, when necessary, the echoic prompt (to favor the emission of the correct response). Additionally, the experimenter pointed out a part of the body and said the name of that part, which could establish conditional auditory-visual discrimination between a verbal stimulus (the dictated name) and a nonverbal stimulus (the body part). In this sense, it is possible to suggest that teaching intraverbal-tact repertoire promoted the learning or strengthening of different operants (echoic, tact, intraverbal and listener), which could facilitate the future acquisition of these operants, as suggested by Sundberg and Partington (1998).

These results might also be explained, to some extent, by the preexistence of correct responses found during the intraverbal-tact baseline tests prior to training. Such correct responses occurred in a very low frequency and may be due to the participants having heard these words (left, right, front, back) during the listener pre-tests and so trying to “guess” the response (picking up one of these words at random) or delayed echoing these words. In future studies, all intraverbal-tact pre-tests could be carried out before introducing listener pre-tests.

Petursdottir and Carr (2011) report that the prevalence of studies that investigated expressive-to-receptive instructional sequences for language teaching to individuals with ASD used tact and selection responses in conditional discrimination trials. In this sense, the results of this study expand previous findings, including questions (intraverbal operant) and listener behaviors that did not involve selection responses. Therefore, the hypothesis that teaching speaker’s repertoires is more effective for emergence of listener’s repertoires than the opposite seems to be confirmed when the procedure involves other operants and spatial relations.

Generalization data, in which the participant should respond under the control of spatial relations to stimuli that had not been used during training (chairs and toy cars), indicate that participants learned right/left and front/back “concepts” (Martin & Pear, 2018). This may have been a function of the use of MET, which was defined by Eby et al. (2010) as a tactic in which different forms of the same stimulus are presented and rotated during teaching (e.g., in the present study, left leg, left ear, left hand; right leg, right ear, right hand). The results of this study suggest that the participants demonstrated generalization to the learned repertoires, corroborating Lafrance and Tarbox’s (2019) statement that MET is a teaching procedure that facilitates stimulus and response generalization.

Inter-individual differences in participants’ performances during the teaching phase (number of blocks for reaching criterion) must not have been a function of the entry repertoire, which was similar for all participants. However, P2 and P4 reached learning criterion in the teaching phase in fewer blocks than the other participants. In order to explain such

more accurate performance by P2 and P4, some hypotheses can be used. P4 was the oldest participant and P2, despite being one of the youngest, received behavioral intervention weekly. P1 also received behavioral intervention weekly, but at the time of this study, he was participating in another research in the few hours he was at the clinic, which may have put a strain on the boy.

This study findings also expands on previous ones that used front/back and right/left relations (Alves & Ribeiro, 2007; Lee, 1981; Luke et al., 2011; Medeiros & Bernardes, 2009) but did not teach or test these relations to body parts and did not check generalization for new stimuli. Future studies should include testing for other relations, such as “Put the watch on your left arm”, “Take the pencil with your right hand”, “Which arm do you put the watch on?”, “With what hand do you write?”.

A limitation of this study refers to the difference in the number of reinforcers produced, because in order to guarantee the same number of blocks in the two teaching procedures, the participant eventually reached 100% correct responses, for example, in the intraverbal-tact teaching before the listener one, which remained for some sessions, implying a greater number of reinforcers for one type of response (intraverbal-tact or listener). P4, for example, presented more correct listener responses during teaching than intraverbal-tact responses, and was the only participant who had more intraverbal-tact correct responses in the posttests, that is, for this participant, “listener-to-intraverbal-tact” teaching (where there was a greater number of reinforced responses during teaching) was more efficient than “intraverbal-tact-to-listener” teaching.

The aim of this study was to compare the effects of intraverbal-tact response (speaker responses) teaching on the emergence of listener responses with the effects of listener response teaching on the emergence of intraverbal-tact responses for body parts and left/right or front/back spatial relations in six young boys with ASD. Intraverbal responses are largely involved in verbal interaction between humans, such as in conversation, answering questions and solving problems (Sundberg & Sundberg, 2011), making the intraverbal a repertoire that should be taught for children with ASD, who present deficits in communication and social interaction.

This study attempted to address a gap in the literature regarding the effectiveness of speaker response teaching in the emergence of listener responses and vice-versa for intraverbal-tact and listener responses for the spatial relations front/back and right/left using body parts. The results of this research suggest that teaching intraverbal-tact speaker responses produced better performances for emergent listener responses than otherwise, corroborating and extending what is proposed by Petursdottir and Carr (2011), Sprinkle and Miguel (2012), Kodak and Paden (2015) and Bao et al. (2017).

These data have an important practical implication in the economy of teaching (or the emergence of responses not directly taught): although, in general, the teaching of listener repertoires requires less effort from the individual,

since the topography of the response is usually the same (pointing, selecting, and so on), the teaching of speaker responses seems to produce the most consistent emergence of novel listener responses.

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#### **Author contributions**

All authors contributed to the study conception and design. Material preparation and data collection were performed by the first author. Data analysis were performed by all authors. The first draft of the manuscript was written by the first author and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

#### **Ethical Approval**

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee. Approval was obtained by the Comitê de Ética em Pesquisa em Seres Humanos – Universidade Federal de São Carlos (Ethics approval number: 2.291.672; CAAE: 76495417.9.0000.5504).

#### **Informed Consent**

Informed consent was obtained from the parents of the children included in the study.

#### **Conflict of interest**

None of the authors involved in this study have any interests that might be interpreted as influencing the research.

#### **Data availability statement**

Research data is available on request from the corresponding author.

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