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Assessing Transfer of Stimulus Control Procedures Across Learners With Autism

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The purpose of this study was to evaluate the effectiveness of 2 transfer of stimulus control procedures to teach tacting to individuals with autism. Five participants with differing verbal skills were assessed by a subset of the ABLLS prior to intervention, then were taught 36 previously unknown tacts using the receptive-echoic-tact (r-e-t) and echoic-tact (e-t) transfer procedures. Each transfer method was used separately to establish different tacts, in a multiple baseline design across tacts for 3 sets of stimuli. The results showed that 4 out of 5 participants (who demonstrated mands, tacts, echoics, and sometimes intraverbals prior to the study) acquired all targeted tacts when either r-e-t or e-t training was presented. One participant (who emitted no verbal operants at the onset of the study) did not acquire any tacts. While some participants appeared to learn more quickly with one transfer method, neither method emerged as more efficient with learners with fewer or more extensive verbal skills. The results indicate that both transfer methods promoted the acquisition of tacts for learners with autism with at least minimal verbal skills.

Key words: transfer of stimulus control, receptive-echoic-tact transfer procedure, echoic-tact transfer procedure, autism

Approaches to understanding and teaching communication skills to children with autism and developmental disabilities have been developed by explicitly applying Skinner's (1957) analysis of verbal behavior (Sundberg & Partington, 1998). These current approaches to early intensive behavioral intervention for children with autism, sometimes referred to as Applied Verbal Behavior, Verbal Behavior, or simply ABA, target the acquisition of distinct and functional verbal operants rather than focusing upon topographies according to the traditional receptive/expressive dichotomy (Lerman et al., 2005). It is this analysis of verbal behavior that will allow behavior analysts to approach topics common in linguistics and psychology (Sundberg, 1998).

A few controlled studies have been conducted on transferring stimulus control between verbal operants in children with autism (Barbera & Kubina, 2005; Drash, High, & Tudor, 1999; Partington, Sundberg, Newhouse, & Spengler, 1994; Sundberg, Endicott, & Eigenheer, 2000).

Sundberg and Partington (1998) have discussed transfer of stimulus control or "quick transfer" procedures extensively. For instance, they described a procedure which transfers control of the spoken response *dog* from a verbal stimulus to respond ("What is that?"), a nonverbal stimulus (picture of dog) and an echoic stimulus (spoken word *dog*) to "What is that?" plus the picture of the dog or the picture of the dog alone. Here, they suggest presenting the picture of the dog to the child along with "What is that?" together with the echoic prompt, "Dog, say 'dog.'" The consequence for the child saying *dog* is praise and possibly physical contact, if that is reinforcing (the physical contact would eventually be faded out, as it is not a typical consequence for tacting). After implementing this part of the procedure, the next step is to fade out the echoic prompt. This may be accomplished by increasing the delay between the question and the delivery of the echoic prompt, or by fading from full to partial echoic prompts. The echoic prompt is continuously reduced until the spoken response *dog* occurs in the absence of the prompt. The stimulus to respond, "What is that?" should also be faded out if the goal is to obtain spontaneous tacting. After this prompt is faded out, the response *dog* is solely under the stimulus control of the nonverbal stimulus and the presence of an audience.

As this study addresses stimulus control and transfer of stimulus control procedures, these terms will be defined briefly. Stimulus control refers to a change in operant behavior that occurs when a particular type of stimulus (S^D or S^Δ) is presented. With an S^D, the behavior occurs in the presence of that stimulus and

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does not occur in its absence. With an S^{Δ}, the behavior does not occur in the presence of that stimulus. Stimulus control develops when a given response is repeatedly reinforced in the presence of a particular stimulus (S^{D}) and not in its absence, or not in the presence of a different stimulus (S^{Δ}). Transfer of stimulus control occurs when behavior initially evoked (controlled) by one S^{D} comes under the control of a different S^{D}. For instance, suppose that a child says *cup* in the presence of the echoic prompt, "Say 'cup.'" If a picture of a cup plus "What is that?" is then presented, the echoic prompt is faded, and the child comes to say *cup* in the presence of the picture of the cup (nonverbal stimulus), transfer of stimulus control from echoic to tact variables has been demonstrated. The response form *cup*, which was previously controlled (evoked) by the verbal stimulus *cup*, is now controlled by the picture of the cup (nonverbal stimulus).

Sundberg and Partington (1998) have suggested several initial behaviors and verbal operants which are important for early learners to acquire. These include approaching a trainer or teacher, emitting a single response to obtain a highly reinforcing item, emitting several responses to gain access to an item or activity over a series of interactions, manding for highly preferred items, imitating actions and verbal stimuli, and complying with instructions. They emphasize the importance of teaching mands as the first verbal operant, as manding allows the learner to gain access to preferred items and activities, and may preclude the development of severe challenging behaviors. Once a child has developed these initial skills, labeling or tact training can begin.

The purpose of the present study was to increase the verbal skills of children with autism; specifically, to establish a tact repertoire. The ability to verbally label everyday items and actions is a cornerstone of language development (Sundberg & Partington, 1998). Tacts play a critical role from the simple tacts of labeling items to complex ones of inferring meaning (Lowenkron, 2004). Children with tacting deficits may experience significant communicative impairments (Barbera & Kubina, 2005). Developing effective procedures for establishing stimulus control, where a child can tact a stimulus within his environment, has wide utility for those children having a difficulty interacting with other individuals.

Barbera and Kubina (2005) evaluated a combination of transfer procedures commonly used to teach tacts to children with autism. These researchers used a combination of receptive-to-echoic-to-tact (r-e-t) and echoic-to-tact (e-t) transfer procedures to teach tacts to one participant with extensive verbal skills. The authors concluded that the concurrent use of the two transfer procedures resulted in the successful acquisition of the targeted verbal operants. Pictures of the target stimuli were placed on a table and the participant was told to "touch ___." The participant received a physical or gestural prompt, if needed, to touch the target stimulus. If he echoed the name of the target stimulus as he touched the picture, the echoic-to-tact transfer was immediately attempted. The picture of the target stimulus was held up and the clinician said, "Right, what is it?" If no response, the clinician said the name of the target stimulus and if the participant echoed the name, the clinician again said, "Right, what is it?" If the transfer to tact was not successful, the clinician went back to the receptive prompt for a different target stimulus by saying "touch ___." If the participant echoed the name of the second target stimulus, the tact transfer was attempted for it. If the participant displayed no echoic response, the third target stimulus on the table was used to attempt the receptive-to-echoic-to-tact transfer. These procedures were combined in a very fluid process, moving quickly from receptive-to-echoic-to-tact or from a nonresponse or error to a receptive prompt. The dual use of these interventions was effective in transferring and establishing stimulus control for the participant. The authors suggested that the receptive component of the r-e-t procedure may facilitate training for children who cannot always be prompted to respond.

The present study extended Barbera and Kubina (2005) by evaluating effectiveness of the r-e-t and e-t transfer procedures in a different format with a larger number of participants with varied verbal repertoires. The present format differed from that of Barbera and Kubina in that r-e-t and e-t procedures were used individually in separate sessions to teach different sets of tacts, rather than in combination to teach all tacts. Since r-e-t and e-t procedures were identical except for the receptive component, one purpose of this study was to evaluate the possible contribution of the receptive component of the procedures.

METHOD

Participants

Four children and one adult participated in this study.

Mike is a 12-year-old boy diagnosed with autism and profound mental retardation. According to his parents, he was verbal until about age two. At the time of this study, his parents also reported that he occasionally vocalized three to five words in context, although this investigator did not observe that he emitted any verbal operants. He vocalized, but did not emit any recognizable words. Mike also did not point to or touch pictures or objects in response to a prompt to do so (i.e., he lacked receptive skills).

Matt is a 6-year-old boy with autism and moderate mental retardation. His father reported that Matt used some words until approximately 12–18 months of age, when he stopped verbalizing. At the time of this study, he manded using 1–2 words, tacted, and emitted echoic behavior.

Bob is an 11-year-old boy with autism and moderate mental retardation. His father indicated that Bob verbalized until approximately 18 months of age, then stopped. According to his mother, Bob's verbal behavior increased in the last couple of years. At the time of this study, Bob manded using 1–2 words, tacted, and emitted echoic behavior.

Jordan is a 12-year-old boy with autism and mild mental retardation. Jordan's parents reported no dramatic regression in his language skills. At the time of the study, Jordan displayed strong echolalia and responded to questions when they were repeated 4–5 times. He also manded and tacted.

Jack is a 21-year-old man with autism and mild mental retardation. His mother reported that he never displayed appropriate language pragmatics as a child. Although he slowly acquired a vocal repertoire, he never emitted responses beyond several words. At the time of this study, Jack's verbal repertoire consisted of mands, tacts, echoics, and intraverbals. He did not converse socially with others.

Prior to intervention, participants' verbal skills were assessed by means of a subset of the ABLLS (Partington & Sundberg, 1998). The ABLLS is a criterion-referenced assessment and skills tracking system designed for children with language delays that informs both parents and professionals regarding a child's current skill levels. It also serves as a curriculum guide and provides information that can serve as a basis for targeting educational objectives. For purposes of the present study, three domains of The ABLLS were used: Receptive Language (52 tasks), Vocal Imitation (9 tasks), and Labeling (42 tasks). Domains assessing receptive skills, echoic behavior, and tacts were selected because these verbal operants were targeted for training in the present study. The 103 items selected from The ABLLS rate each task on a scale from 0–2 or 0–4, and the results for each of the 103 tasks were added to produce a summative rating for each participant. By means of these ratings, the verbal skills of each participant were quantified to obtain ordinal data for comparison across participants. The participants' summative ratings on these domains of the ABLLS are as follows: Jack, 331; Jordan, 267; Bob, 175; Matt, 85; and Mike, 10. Participants' scores on all three domains of the ABLLS followed the same pattern as their cumulative "rankings"; that is, Jack had the highest scores in all three domains, Jordan had the second highest scores, Bob, the third, etc. Thus, participants' skill levels were consistent across the three domains. Based on both the cumulative assessment and individual domain data, Jack might be expected to acquire tacts with fewest trials to criterion.

Setting

All sessions took place in the participants' homes, at the dining room table. The clinician sat next to the participant, on the side corresponding with his dominant hand. The settings were not controlled for background noise.

PROCEDURES

Dependent Variable Identification

A pool of approximately 200 pictures of objects was pretested in order to select unknown stimuli to be tacted. The stimulus pictures, each showing one object, were obtained from age-appropriate school books and magazines and displayed on white 3 x 5" index cards. Each participant was presented with the pictures on the index cards and asked to tact them. If a participant failed to tact a picture correctly, that

picture was included in the study. This procedure was repeated until 36 unknown pictures were identified for each participant. The pictures were then randomly distributed into three sets of twelve—Set 1, Set 2, and Set 3. The stimulus pictures remained constant for each specific transfer procedure during the training sessions; that is, with each set of pictures, specific stimuli were used in r-e-t training and others in e-t training. No picture was used with both transfer procedures. Identical procedures were conducted individually for all participants, except that with Mike, only one set of stimulus pictures was presented. The sets of stimulus pictures and transfer methods used for each participant are displayed in Tables 1–5.

Research Design and Baseline

In the present study, the effectiveness of r-e-t and e-t transfer procedures was assessed via a multiple baseline design across behaviors (i.e., Set 1, Set 2, and Set 3 tacts). In the initial session for each set of stimulus pictures, participants were prompted to tact the pictures displayed on the index cards, as in the cold probe procedure. No training was presented in these sessions. There were at least four baseline/probe sessions implemented with each set of stimuli to determine whether the data were stable. After stability was achieved, training commenced on Set 1 stimuli, while baseline measures continued to be gathered on sets 2 and 3. After about 12 sessions, after the participant acquired a number of Set 1 tacts, training began for Set 2, while baseline measures continued for Set 3. After approximately 18 sessions, after the participant acquired several Set 2 tacts, training began for Set 3. Thus, the progression to training on Sets 2 and 3 was determined by the data, in a multiple baseline fashion.

Training Procedures (Independent Variables)

Sets 1, 2, and 3 each consisted of 12 stimulus pictures to be tacted. Six were trained with the r-e-t procedure and 6 with the e-t procedure. Again, the transfer methods remained constant for each targeted tact with no cross-training (i.e., no tact was trained using both r-e-t and e-t procedures). Beginning with r-e-t, three stimulus pictures were placed in front of the participant and the participant was prompted to touch the targeted picture by saying, "Touch …" This was the receptive component of the intervention. Most-to-least prompting ensured that the participant touched the correct picture. After the participant touched the targeted picture, he was verbally prompted to echo the name of the picture by saying, "Say …" . This was the echoic component of the intervention. If he did not respond correctly, a whole word prompt (fading to partial word then an initial sound) was employed to ensure a correct response. After echoing, the participant was prompted to tact the targeted picture by saying, "Right, what is it?" Again, whole-partial-initial sound prompting was employed. In e-t training, the participant was presented with one picture at a time. The participant was then prompted to "Say …" (echoic relation), then "Right, what is it?" (tact relation). This method was identical to r-e-t training except that only one picture was presented and no prompt to touch the picture was given; that is, the e-t procedure did not include the receptive component.

For all participants, a specific training sequence was followed for the 36 tacts. For Sets 1, 2, and 3 (each consisting of 12 tacts), r-e-t training was implemented for items 1, 2, 3, 7, 8, and 9, and e-t was implemented for items 4, 5, 6, 10, 11, and 12. Thus, the training method alternated every three tacts; that is, after training tacts 1, 2, and 3 with r-e-t procedures, e-t methods were used for tacts 4, 5, and 6, etc.

The training segments were equally divided in time between the r-e-t and e-t transfer procedures. After the first three pictures were correctly responded to by the participant through r-e-t training, the next prescribed three were trained by the e-t transfer procedure. The clinician held a picture of the targeted tact, prompted the child to repeat the name, and say the name of it (echo). If the child did not respond correctly, then the previous correction procedure for the echoic prompt was employed until he correctly responded (most to least prompt fading). After an echoic response was emitted by the participant, the clinician asked him to tact it while the picture remained displayed, "Right, what is it?" The same correction procedure previously mentioned for tacting was used. If the participant was unable to emit an echoic prompt, his training continued for the set of three tacts until the allotted time

Table 1
Mike's Three Sets of Targeted Tacts and the Transfer Method Employed (Only Set 1 was Used)

Transfer method	Set 1	Transfer method	Set 2	Transfer method	Set 3
r-e-t	ball	r-e-t	socks	r-e-t	leaf
	cat		bird		monkey
	flowers		baby		phone
e-t	doll	e-t	apple	e-t	cup
	boot		pants		jet
	bat		shoes		watch
r-e-t	shirt	r-e-t	pear	r-e-t	moon
	tie		pen		fan
	dog		hat		towel
e-t	ring	e-t	mouse	e-t	tree
	boat		toothbrush		lemon
	car		TV		star

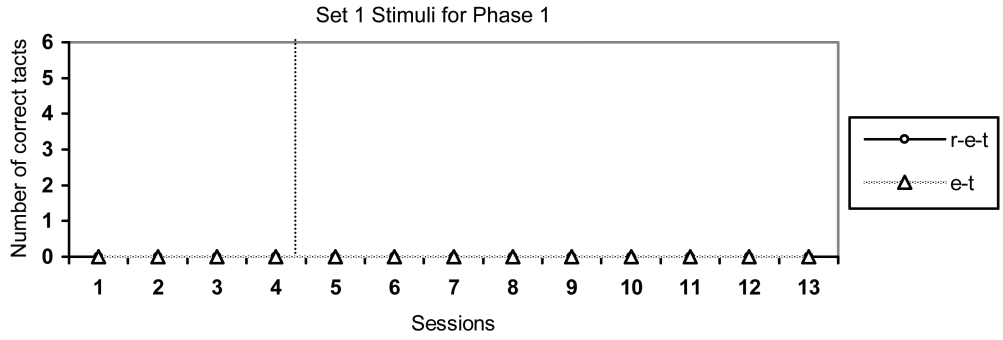

Figure 1. Mike's responses for Set 1.

(as determined by the specific experimental phase) expired. If he was unsuccessful after the allotted time had expired, training continued to the next set of designated tacts.

Experimental phases. The study was conducted in three phases. For each participant, Phase I consisted of r-e-t and e-t training for Set 1 tacts only, and occurred for 6 minutes (3 r-e-t + 3 e-t) per session. For all participants except Mike, Phase II (training and/or maintenance for Set 1 and training for Set 2) began after the participant had acquired a number of tacts in Set 1, either via r-e-t or e-t training. The decision to move to Phase II was made individually for each participant, based on his successful performance in Phase I. During Phase II, Set 1 training and/or maintenance trials occurred for 4 minutes per session (2 r-e-t + 2 e-t) and Set 2 training trials were implemented for 6 minutes (3 r-e-t + 3 e-t) within the same session. For all participants except Mike, Phase III (maintenance for Set 1, training and/or maintenance for Set 2, and training for Set 3) began after the participant had acquired a number of tacts in Set 2, either with r-e-t or e-t training. During Phase III, Set 1 maintenance trials were implemented for 2 minutes (1 r-e-t + 1 e-t) per session, Set 2 training and/or maintenance trials for 4 minutes (2 r-e-t + 2 e-t) per session,

Table 2
Matt's Three Sets of Targeted Tacts and the Transfer Method Employed

Transfer method	Set 1	Transfer method	Set 2	Transfer method	Set 3
r-e-t	gibbon	r-e-t	muskrat	r-e-t	ant
	hook		lightning		skeleton
	kazoo		brief case		cactus
e-t	galaxy	e-t	armadillo	e-t	dolphin
	chimpanzee		church		bacon
	engine		flip flops		ceiling fan
r-e-t	harp	r-e-t	palm tree	r-e-t	beaver
	diamond		hat		jack
	copier		ring		outlet
e-t	birdhouse	e-t	lizard	e-t	seal
	grill		tomato		boots
	lobster		pants		elk

and Set 3 training trials for 6 minutes (3 r-e-t + 3 e-t) per session. Times between sessions were recorded across participants, based on their varying availabilities. These times varied from 24 hours to 5 days.

Trials were conducted identically with all participants, regardless of their entering skills, as assessed in three domains of the ABLLS (Partington & Sundberg, 1998), as described earlier. The participants assessed with fewer verbal skills were trained in exactly the same way as those with more extensive verbal skills.

Results

Interrater reliability. Prior to the study, a parent was trained in the interventions used in the study, for each participant. This trained parent observed and collected data in at least 30% of all sessions that were conducted by the clinician. At the conclusion of each session observed by the parent, the parent and clinician compared data. Interrater reliability was determined by dividing the number of agreements by the total amount of trials, and multiplying by 100. Interrater reliability was 100% across all participants.

Data analysis. Figures 1–5 show tact performance for each participant. With all participants except Mike, each figure contains 3 successive graphs showing Set 1, Set 2, and Set 3 tact performance before and after the r-e-t or e-t procedures were presented. With Mike, the figure includes one graph showing his acquisition of Set 1 tacts before and after r-e-t and e-t training. This data display format is designed to reveal any educationally significant effects on the dependent variables that can be attributed to the independent variable. In combination with the ABLLS assessments (Partington & Sundberg, 1998), it might be revealed that one variation of the independent variable, r-e-t or e-t, is more (or less) effective with individuals with more (or less) complex verbal repertoires. On the other hand, it is possible that both variations of the independent variable may be equally effective with all participants.

Mike

Figure 1 shows tact performance for Mike. As indicated in the graph, he failed to acquire any of the targeted tacts in Set 1. Based on this performance, the decision was made to discontinue the intervention and not attempt to train the Set 2 and Set 3 tacts that had been initially targeted. Mike's Set 1 performance suggested that it was unlikely that he would acquire tacts in Set 1 or Set 2, as the pool of tacts was randomly distributed prior to training. The intervention lasted 13 sessions, with Mike learning 0 tacts over 15 days.

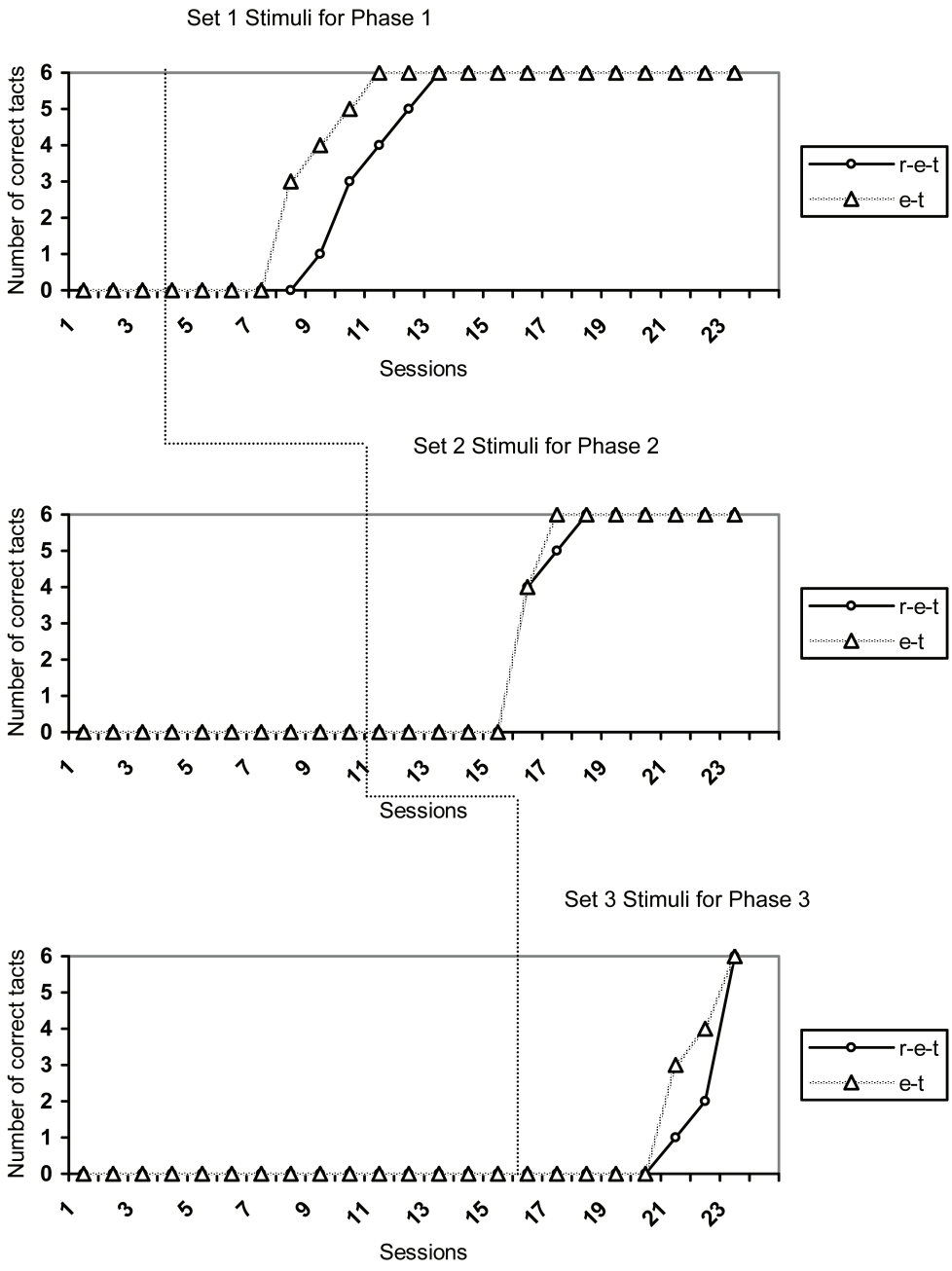

Figure 2. Matt's responses across sets of tacts.

Matt

Figure 2 shows tact performance for Matt. For Set 1, 5 baseline sessions were completed during which Matt did not correctly respond (or respond at all) for any of the tacts in the set. The training sessions began after the cold probe for Session 5. Acquisition then occurred more quickly for the targeted tacts using the e-t method than for the r-e-t method, with Matt reaching mastery two sessions earlier during the e-t method.

During training with Set 2, Matt responded incorrectly during all 12 baseline sessions. The

Table 3
Bob's Three Sets of Targeted Tacts and the Transfer Method Employed

Transfer method	Set 1	Transfer method	Set 2	Transfer method	Set 3
r-e-t	sword	r-e-t	pitchfork	r-e-t	iron
	helmet		cymbals		cereal
	chinchilla		i-pod		pickle
e-t	ax	e-t	jack	e-t	pie
	outlet		lighter		skier
	unicycle		bolt		barrels
r-e-t	lightning	r-e-t	keyboard	r-e-t	tuning fork
	compass		flip flops		chocolate
	eclipse		rug		kazoo
e-t	barbell	e-t	copier	e-t	engine
	coyote		vineyard		suspenders
	treadmill		ceiling fan		trombone

training procedure was initiated after 7 teaching sessions for Set 1. Matt mastered the e-t tacts 1 session before those trained using r-e-t. The rate of acquisition was nearly identical for both methods.

For Set 3, the training procedure was initiated after Set 1 was taught for 12 sessions and Set 2 for 5. Thus, baseline for Set 3 was conducted for 17 sessions. Matt achieved mastery criteria simultaneously for both methods; early on, however, his rate of acquisition was slightly quicker using the e-t method. The entire intervention lasted 23 sessions, whereby Matt learned 36 tacts over 31 days.

Bob

The results showing tact acquisition for Bob are displayed in Figure 3. Five baseline sessions were implemented for Set 1. During these baseline sessions, Bob did not emit any correct tacts. Training began after the cold probe was conducted in Session 5. He met mastery criteria for tacts trained via r-e-t one session before mastery of e-t tacts; however, the rate of acquisition for both methods was very similar. Additionally, the transfer method resulting in quicker acquisition fluctuated three times before mastery was achieved with both methods.

During Set 2, Bob responded incorrectly during all 12 baseline sessions. The training procedure was initiated after 7 teaching sessions for Set 1. The more effective transfer method was evident during this set. He achieved mastery criteria for the r-e-t tacts 3 sessions prior to those using e-t. Moreover, the rate of acquisition was quicker for the r-e-t tacts.

For Set 3, baseline procedures were conducted for 17 sessions; Set 1 was taught for 8 sessions, and Set 2 for 6. Bob achieved mastery criteria simultaneously with both transfer methods and his rates of acquisition were identical. Bob acquired 36 tacts over 30 days, and the intervention lasted 22 sessions.

Jordan

The results showing tact acquisition for Jordan are displayed in Figure 4. For Set 1, 5 baseline sessions were implemented prior to training. During baseline, Jordan did not correctly tact any targeted stimulus pictures. During training, he acquired the r-e-t tacts more quickly, resulting in the mastery criterion being met 2 sessions earlier with r-e-t than the e-t method.

During training on Set 2, Jordan responded incorrectly during all 14 baseline sessions. The training procedure was initiated after 9 teaching sessions for Set 1. For Set 2, Jordan achieved

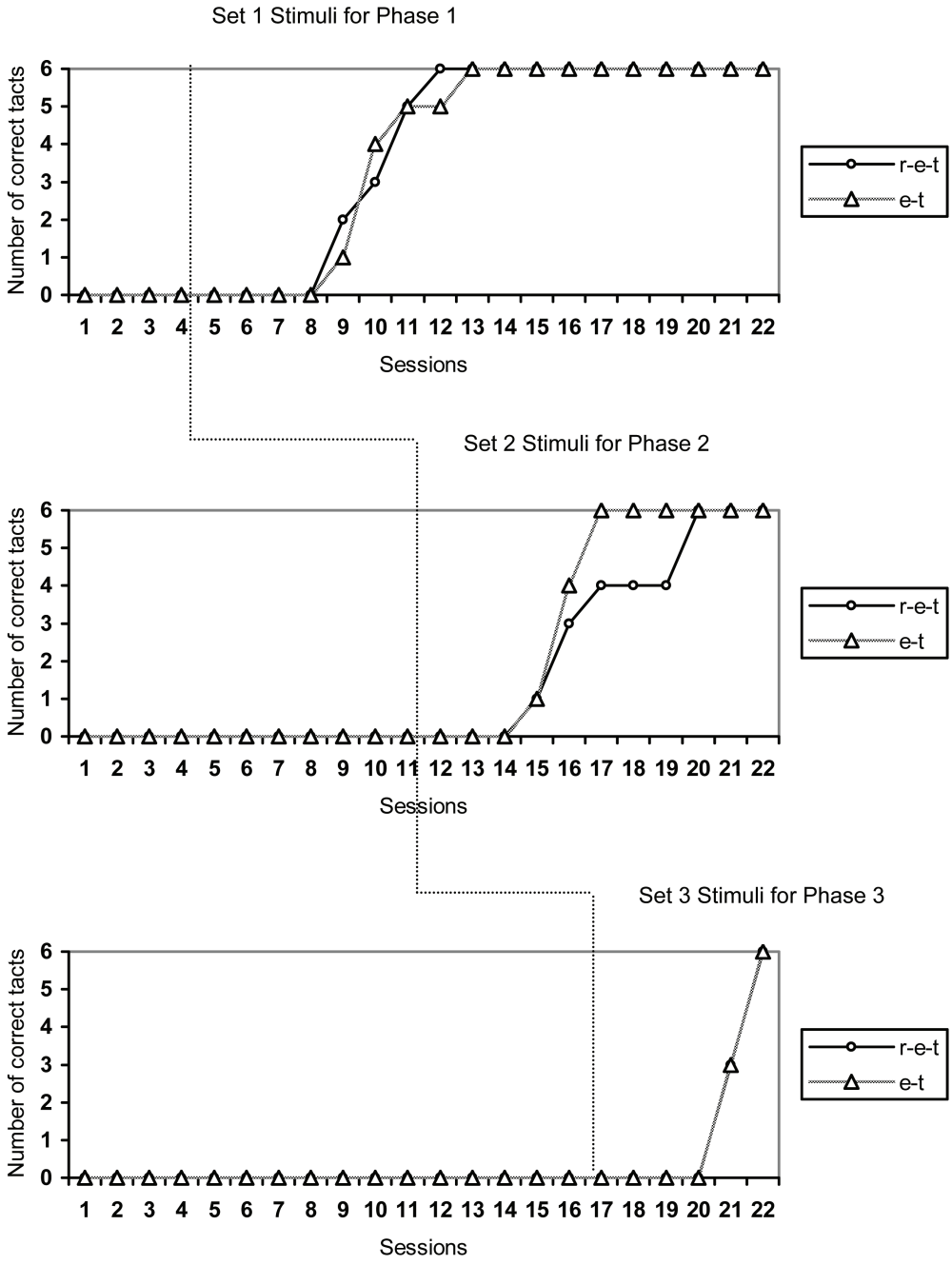

Figure 3. Bob's responses across sets of tacts.

mastery simultaneously for both the r-e-t and e-t tacts. Moreover, with the exception of one session, rate acquisition was identical for both transfer methods.

For Set 3, baseline was conducted for 19 sessions, during which Jordan failed to correctly respond to the targeted tacts. When training was initiated for Set 3, training had been conducted for 14 sessions in Set 1 and 6 sessions in Set 2. He achieved mastery criterion for r-e-t tacts one session before those using e-t methods, although the rate of acquisition between

Table 4
Jordan's Three Sets of Targeted Tacts and the Transfer Method Employed

Transfer method	Set 1	Transfer method	Set 2	Transfer method	Set 3
r-e-t	scorpion	r-e-t	chimpanzee	r-e-t	wildebeest
	Saturn		suspenders		centipede
	engine		crystal		porcupine
e-t	lemur	e-t	cheetah	e-t	platypus
	syringe		church		chandelier
	car seat		emu		baboon
r-e-t	dumbbell	r-e-t	tuning fork	r-e-t	ferret
	squid		stained glass		aardvark
	compass		microchip		praying mantis
e-t	wolverine	e-t	wallaby	e-t	i- pod
	cockroach		submarine		arrow
	orangutan		galaxy		bow tie

the methods did not considerably differ. The entire study took place over 25 sessions, in which Jordan learned 36 tacts over 33 days.

Jack

The results of tact acquisition for Jack are displayed in Figure 5. For Set 1, four baseline sessions were implemented prior to training. During baseline, Jack did not tact any targeted stimuli correctly. He achieved mastery criterion with the e-t method 1 session before those employing r-e-t; however, the transfer method resulting in quicker acquisition fluctuated four times before mastery was achieved for e-t.

During Set 2, Jack responded incorrectly during all 11 baseline sessions. Training had been implemented for 7 sessions in Set 1 at the commencement of training for Set 2. For Set 2, Jack achieved mastery criteria simultaneously for both the r-e-t and e-t tacts, though his acquisition rate was slightly quicker with the e-t tacts.

For Set 3, baseline was conducted for 18 sessions, during which Jack failed to correctly respond to the targeted tacts. When training was initiated for Set 3, training had been conducted for 14 sessions in Set 1 and 7 sessions in Set 2. Jack achieved mastery criteria simultaneously for both methods; however, his rate of acquisition was slightly quicker using the e-t method. The intervention lasted 24 sessions, whereby Jack learned 36 tacts over 41 days.

DISCUSSION

The data show that the r-e-t and e-t procedures were effective in establishing tacts in four out of five participants when they were presented separately in sessions separated by at least 24 hours rather than in the combined manner utilized by Barbera and Kubina (2005). Further, these procedures were used effectively with participants with varied verbal repertoires. In the case of Mike, however, tact training was unsuccessful. This may be due to differences in Mike's entering verbal repertoire compared with the other participants. Mike did not emit conventional verbal topographies under any conditions prior to the study, whereas all of the other participants emitted mands and other verbal operants.

Regarding the effects of the different transfer procedures, with the exception of Jordan and Mike, all participants appeared to respond slightly better when the e-t transfer method was used. This conclusion is sug-

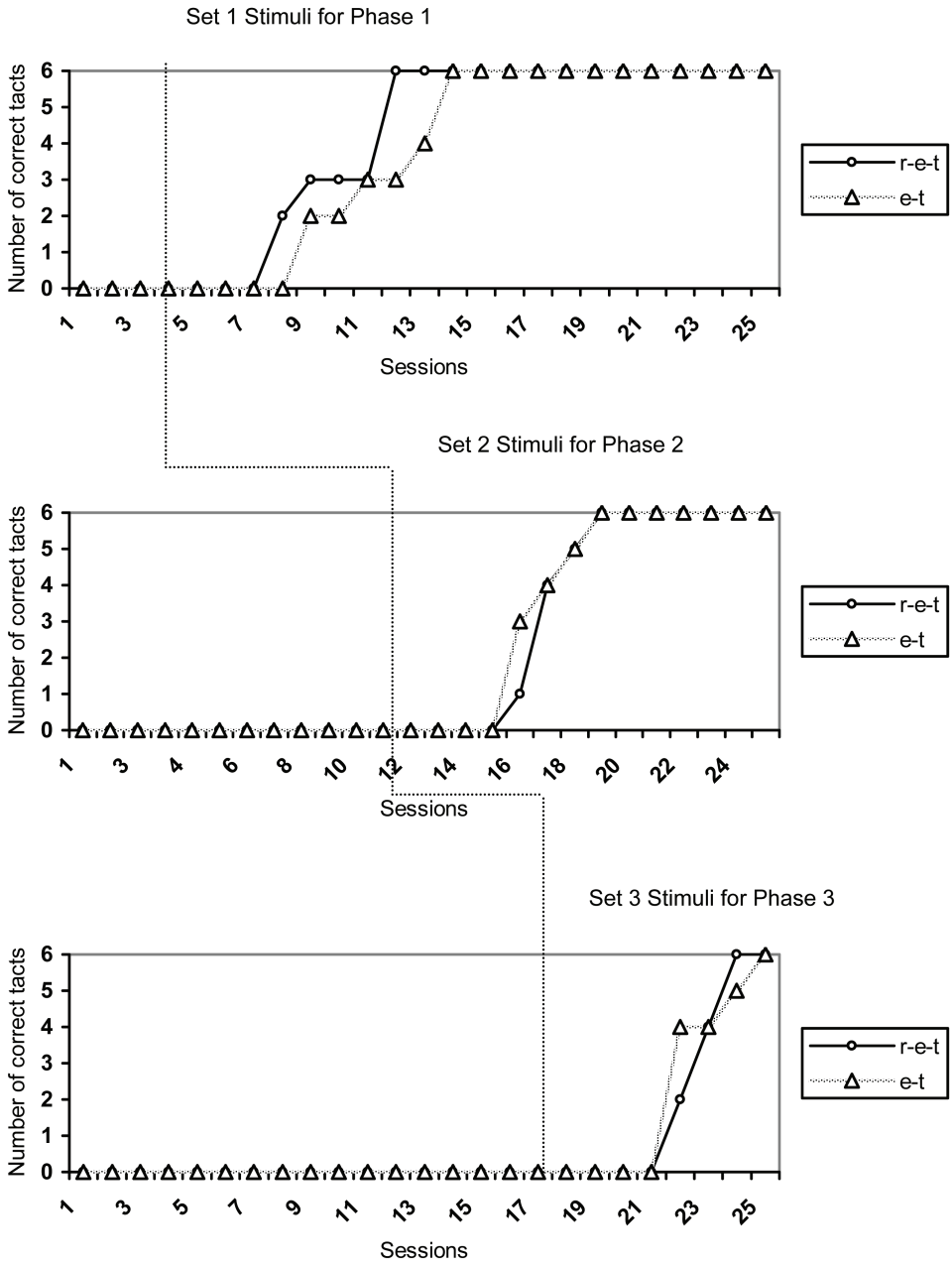

Figure 4. Jordan's responses across sets of tacts.

gested by the faster learning rate across sets. Jack, Bob, and Matt appeared to have mastered e-t tacts more quickly for at least 2 of the 3 sets of tacts. This conclusion, although visually apparent in the graphs, should not be overemphasized, as the difference in acquisition between e-t and r-e-t methods was marginal. The difference for Jordan is not as clear, for he responded better to r-e-t tacts during the initial set and responded very similarly using e-t methods during the later sets. No differences were present with Mike, since he did not acquire any tacts.

One issue to consider is the possibility of sequence effects when comparing the effects of r-e-t and e-t training. This concern is related

Table 5
Jack's Three Sets of Targeted Tacts and the Transfer Method Employed

Transfer method	Set 1	Transfer method	Set 2	Transfer method	Set 3
r-e-t	protractor	r-e-t	cuff links	r-e-t	lemur
	skis		flash drive		peacock
	javelin		emery board		aardvark
e-t	shoe horn	e-t	crystal	e-t	platypus
	windmill		recliner		baboon
	ferret		tweezers		coyote
r-e-t	compass	r-e-t	shoulder pads	r-e-t	chinchilla
	cockroach		armoire		centipede
	tulip		eclipse		armadillo
e-t	screwdriver	e-t	cleat	e-t	seal
	metal detector		gibbon		unicycle
	crutch		jack		orangutan

to what the participant is actually doing in the e-t condition, and whether this may have been affected by prior r-e-t training. The receptive skills acquired in r-e-t become part of the participant's repertoire, which might enhance the effectiveness of later e-t training. Receptive responding could facilitate the acquisition of tacts in the following manner. In r-e-t training, the participant is presented with three pictures of items (nonverbal stimuli) and prompted to "Touch___." He or she is then prompted to touch the nonverbal stimulus using most-to-least prompting, if necessary. Thus, in the presence of the spoken word for an item, the participant acquires a repertoire of looking at, scanning the three nonverbal stimuli, and touching the stimulus that corresponds with the vocal word. When a single stimulus is later presented in the e-t condition, the participant exposed to r-e-t training may have a tendency to look closely at it and point to/touch it (receptive responding), which might set the occasion for the nonverbal stimulus to gain control over the form of the verbal response more quickly. There is no evidence that behavior trained in the r-e-t condition occurred in the e-t alone condition (it might be necessary to videotape the session to determine this), but the possibility has not been ruled out.

It appeared that the effectiveness of the transfer procedures was dependent on the verbal skills of the participants. The data indicate that the participants' initial communicative repertoires, and not the type of procedure, were the main determinants of their performance. Their verbal abilities at the commencement of the study appeared to determine their responding efficiency, rather than either transfer method implemented during the study. The data further suggest that both methods were generalizable across participants. It appears that from Jack to Matt (excluding Mike who failed to respond at all), both methods increased responding. While it was earlier mentioned that e-t methods were slightly preferred, both methods were effective across learners of varying verbal abilities.

Which transfer method appeared to be more effective across learners of different language abilities? Unfortunately, the data are inconclusive in suggesting a definitive response. The participants' responses from the subset of The ABLLS (Partington & Sundberg, 1998) suggest five unique verbal abilities. There appears to be no relation to these abilities and method preference. For instance, Eric (summative score of 58) did not show method-specific responding preference that differed significantly from Jack

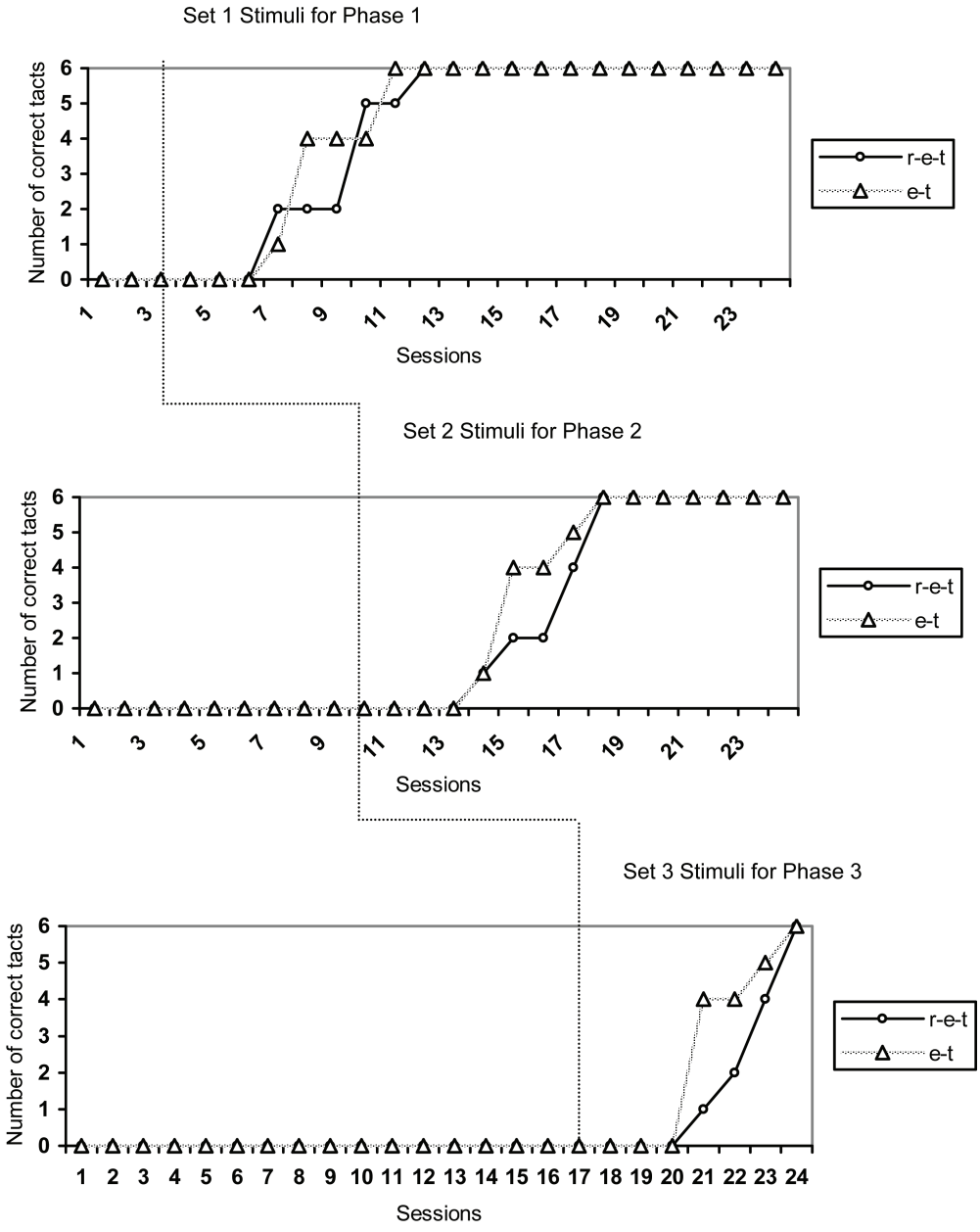

Figure 5. Jack's responses across sets of tacts.

(summative score of 331). From the data, there is no evidence that either method is more effective when teaching tacts to learners with autism with differing verbal skills. Individuals with more (or less) complex verbal skills did not respond much differently to e-t than r-e-t training. Thus, the receptive component of r-e-t did not seem to add value to the training, with these participants. In future research of this nature, it may be necessary to assess participants' entering receptive skills more closely. It is possible that with participants who already exhibit receptive skills at the onset of the study, the receptive component of r-e-t would not greatly strengthen their tendency to look at or touch the stimulus pictures.

Limitations

There are several possible limitations to this study. One consideration when analyzing the results should be the mastery criteria for a successful tact. A tact was deemed to be mastered when there were 3 consecutive correct responses during the cold probe sessions. Although it seldom occurred, there were instances where a participant correctly responded once or twice and then did not respond correctly. Mastery criteria being 3 consecutive successful responses, the participant had to return to zero after the incorrect response, regardless of a correct history of responding for that tact. In other words, the participant received 'no credit' for responding correctly once or twice. Theoretically, a participant could have correctly responded 15 times, missed 1 cold probe trial, and would have been required to tact the item 3 additional times before mastery was again documented. A confounding variable may have been present in the aforementioned trial and resulted in an incorrect response. This could be a potential threat to internal validity, as the changes in the dependent variable may have not resulted from the application of the independent variable. This scenario did not occur, but was possible. Perhaps a mastered tact could have been defined as two consecutive responses. Further, a mastered tact could have been defined as one correct response but exit criteria for the set (12 total tacts) could have been three consecutive correct trials.

While mastery criteria may have been a limitation, all participants were exposed to both r-e-t and e-t methods equally. This safeguard would suggest that a limitation in mastery criteria should have equally affected both transfer methods. Thus, it should not have greatly compromised the results.

Another potential limitation was the varying of session frequencies across participants. As previously noted, each participant had an equal exposure to both independent variables. The number of sessions needed for mastery of all 36 tacts cannot be compared across participants. Jack, who was assessed to possess the highest communicative ability, required more training sessions to meet exit criteria (24) than were required by Matt (23). A plausible explanation could be that Jack's sessions occurred over a span of 41 days while Matt's training sessions occurred over a span of 23 days. While this issue appears unrelated to the question of which transfer method is more efficient, one should exercise caution in generalizing the study's results across participants.

Future Research

Areas remain to be explored in assessing the effectiveness of transfer of stimulus control procedures. A possible route could be to assess r-e-t versus e-t methods across a number of participants of similar verbal abilities. Perhaps more participants resembling Jordan's verbal profile would respond to one method more effectively than another.

If r-e-t and e-t training were compared with participants entering the study with minimal receptive repertoires, if might also be desirable to use a different experimental design to control for the possibility of sequence effects. As mentioned earlier, sequence effects are possible because the receptive component of r-e-t training might change the participant's attending repertoire and thus affect his or her responding in the e-t condition. A different experimental design might therefore be used in which the orders of r-e-t and e-t training were counterbalanced with different participants.

An additional direction for future research might be to incorporate mand training in the acquisition of tacts. Arntzen & Almås (2002) reported that a combination of mand-tact training, rather than tact-only training led to a more rapid acquisition of tacts. It has been demonstrated that mand contingencies involve stronger controlling variables and may facilitate the acquisition of a tacting repertoire. These authors suggest that changes in one verbal repertoire may result in collateral changes in a second. The mand-tact condition provides the opportunity to train two verbal operants as quickly as one verbal operant in a tact-only condition. Mand training could be incorporated with training using the receptive prompt. After a successful receptive prompt to identify the targeted tact, the experimenter could then hide the picture and use the instructions "Find the ___." When the participant couldn't find the object, he would be prompted to mand for it. Employing this operant in the transfer method sequence, it could be considered a receptive-mand-echoic-tact (r-m-e-t) procedure. The meth-

ods r-e-t, e-t, and r-m-e-t could then be assessed to determine effectiveness of tact acquisition.

CONCLUSION

This study adds to the body of literature that suggest that both r-e-t and e-t transfer methods are effective in teaching tacts to people with autism, providing that they exhibit some verbal responding prior to intervention. The receptive component of the intervention was not necessary in establishing tacts, at least with these participants. This study appears to have value for teachers and clinicians serving students with autism.

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