*THE ROLE OF INCREASED EXPOSURE TO
TRANSFER-OF-STIMULUS-CONTROL PROCEDURES ON THE
ACQUISITION OF INTRAVERBAL BEHAVIOR*

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Studies that have compared the effectiveness of differing prompt types to teach intraverbal responses have yielded mixed results, suggesting that individuals' reinforcement histories with prompt types may influence which prompt will be most effective. The purpose of this study was to test whether programmed increases in exposure to specific prompt types would produce concomitant increases in the acquisition rate of intraverbal responding. We compared acquisition rates among 4 typically developing preschool-aged children when taught via either echoic or tact prompts following exposure training with 1 prompt type. For all participants, the prompt method most recently used to teach intraverbal responses required fewer trials to teach new intraverbal responses compared to a prompt method that had not been used recently. The results are discussed in terms of the effects of reinforcement history on the acquisition of verbal behavior.

Key words: echoic, intraverbal behavior, prompting strategies, tact, verbal behavior

Intraverbal responses are verbal operants that have no point-to-point correspondence with the verbal stimuli that evoke them. In other words, the beginning, middle, and end of the verbal response do not match the beginning, middle, and end of the preceding verbal stimulus (Cooper, Heron, & Heward, 2007). Intraverbals are established and maintained by generalized conditioned reinforcement (Skinner, 1957). An example of an intraverbal response is saying "blue" when hearing, "What's your favorite color?" or saying "moo" as a result of hearing the phrase, "The cow says —."

Along with the other elementary verbal operants, an effective intraverbal repertoire plays an important role in successful communication skills that include many aspects of day-to-day social interaction, including answering

questions and continuing conversations. Typically developing children may develop intraverbal repertoires without direct instruction through exposure to the numerous verbal exemplars that they encounter on a daily basis (Hart & Risley, 1995). On the other hand, children with developmental disabilities may have difficulty acquiring an effective intraverbal repertoire, severely limiting opportunities for meaningful social interaction and development (Sundberg & Michael, 2001).

Several methods for transferring stimulus control to the intraverbal response have been suggested in the literature. These involve the presentation of a stimulus (prompt) that already exerts some control over the behavior, concurrently or immediately following the presentation of the target verbal stimulus. Echoic (i.e., auditory; Ingvarsson, Tiger, Hanley, & Stephenson, 2007; Pérez-González, García-Asenjo, Williams, & Carnerero, 2007; Petursdottir, Carr, Lechago, & Almason, 2008; Secan, Egel, & Tilley, 1989; Watkins, Pack-Teixeira, & Howard, 1989), textual (i.e., written; Krantz & McClannahan, 1993, 1998; Sarokoff, Taylor, & Poulson, 2001; Thiemann & Goldstein, 2001), and tact (i.e., visual; Braam & Poling, 1983; Goldsmith, LeBlanc, & Sautter, 2006;

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Luciano, 1986; Miguel, Petursdottir, & Carr, 2005) prompts are then faded systematically until the target verbal stimulus alone evokes the behavior.

In addition to demonstrating the effectiveness of these different prompting procedures, a few studies also have compared them directly (Finkel & Williams, 2001; Ingvarsson & Hollobaugh, 2011; Ingvarsson & Le, 2011; Vedora, Meunier, & Mackay, 2009). Finkel and Williams (2001), for example, compared the effects of textual and echoic prompts on the acquisition of intraverbal behavior in a 6-year-old boy with autism. Results were consistent with previous research that suggested that both forms of prompts were effective in teaching intraverbals. However, textual prompts were more effective than echoic prompts, as measured by overall accuracy and number of questions answered using target full-sentence responses. In a follow-up study, Vedora et al. (2009) compared the effects of textual and echoic prompts on the acquisition of intraverbals in two children with autism. Although both prompting methods were successful, the participants met the performance criterion more quickly with textual prompts than echoic prompts, again suggesting that textual prompts may be more effective in teaching intraverbal behavior. Ingvarsson and Hollobaugh (2011) compared the efficiency of echoic and tact (picture) prompts for teaching intraverbal responses to three 4-year-old boys with autism. Again, both prompts were effective in teaching the target responses, but tact prompts resulted in fewer trials to criterion for all participants. These results are consistent with those of Finkel and Williams and Vedora et al., demonstrating the superiority of visual prompts over auditory ones. On the other hand, in a comparison of echoic, tact, and textual prompts, Ingvarsson and Le (2011) found that four children with autism met the performance criterion more quickly with echoic prompts than with tact or textual prompts.

Continuous access to the visual stimulus during the transfer-of-control procedure may account for the effectiveness of visual prompts (textual and tact prompts; Vedora et al., 2009). However, topographical similarity between auditory stimuli and responses may play an important role in the effectiveness of echoic prompts. Differences among participants' reading levels also may explain the disparities in prompt effectiveness across studies (Finkel & Williams, 2001).

Some authors also have suggested that participants' history with different prompting methods may play an important role. Finkel and Williams (2001) stated that their participant likely had a long history of ineffective learning using echoic prompts that facilitated greater levels of attention to the textual stimuli. It seems plausible that differences in prompt effectiveness may be due to individuals' history of reinforcement with various prompting methods.

Research has shown that reinforcement history can influence schedule performance (Lattal & Neef, 1996). However, the influence of reinforcement history on responding under different stimulus conditions has not yet received empirical attention with regard to acquisition of verbal behavior. The purpose of this study was to test whether programmed increases in exposure to specific prompt types would produce concomitant increases in the acquisition rate of intraverbal responding.

METHOD

Participants, Setting, and Materials

Participants were four typically developing children: Kevin (4 years old), David (3 years old), and monozygotic twins Chasin and Adam (4 years old). We selected typically developing children as participants to minimize the likelihood of extraexperimental exposure to prompting methods that are common for children who undergo behavioral interventions. All participants were native English speakers.

Table 1
Translations Taught

pomme/apple	poisson/fish	lit/bed	vache/cow
savon/soap	lait/milk	canard/duck	verres/glasses
piscine/pool	cheval/horse	toboggan/slide	oiseau/bird
chaise/chair	bateau/boat	terrine/bowl	horloge/clock
serpent/snake	feuille/leaf	poulet/chicken	marteau/hammer
livre/book	cochon/pig	chapeau/hat	fromage/cheese
chien/dog	grenouille/frog	fraise/strawberry	voiture/car
araignée/spider	chemise/shirt	souris/mouse	maïs/corn
vélo/bike	lapin/rabbit	balai/broom	parapluie/umbrella
touches/keys	seau/bucket	couteau/knife	gâteau/cake
moutons/sheep	couler/sink	potiron/pumpkin	chaussette/socks
couverture/blanket	serviette/napkin	paille/straw	pain/bread
dindon/turkey	cloche/bell	papillon/butterfly	pomme de terre/potato
fourmi/ant	maison/house	pluie/rain	porte/door
fenêtre/window	herbe/grass	saleté/dirt	école/school
buisson/bush	lune/moon	étoile/star	pont/bridge
drapeau/flag	tambour/drum	beignet/donut	camion/truck
ver/worm	nuage/cloud	glacée/ice cream	balançoire/swing

Parents and caregivers of all participants were briefed prior to the start of the study to refrain from supplementary teaching of French-to-English translations.

Sessions were conducted in a secluded area of the participants' homes. During each session, the participant was seated at a table next to the experimenter. Materials included data-collection sheets and picture cards (9 cm by 13 cm) selected from the "Language Builder: Picture Noun Cards" by Stages Learning Materials for tact prompting trials. The picture cards remained out of sight during echoic prompting trials.

Dependent Variables

Dependent variables included (a) the number of trials to criterion, (b) the number of correct answers to target questions, and (c) mean number of errors or incorrect responses across sessions. Correct answers were scored for English vocal responses that were accurate translations of French words (see Table 1). Examples of correct answers included the response "house" following the question, "What is maison?" English vocal responses that were inaccurate translations of French words were scored as incorrect. Examples of incorrect answers included the response "house" following the question, "What is

chat?" Incorrect answers also were scored for responses that were inaudible or unclear, or if no response was emitted within 5 s of the presentation of the experimenter's question.

Interobserver Agreement

Interobserver agreement was assessed during 50% of sessions. An agreement was defined as a correct or incorrect answer to a target question scored by both the experimenter and independent observer on a single trial. A disagreement was defined as the experimenter scoring a response as correct and the independent observer scoring a response as incorrect on a single trial or vice versa. Interobserver agreement was calculated on a trial-by-trial basis by dividing the number of agreements by the number of agreements plus disagreements within each block and converting that number to a percentage. The agreement range for trial blocks across participants was 56% to 100%. Although there were some trial blocks with low agreement, the majority of them had very high percentage agreement. Mean agreement for responses across participants ranged from 97% to 99%.

Treatment Integrity

Treatment integrity was assessed during 50% of sessions. An independent observer recorded

antecedents and consequences delivered by the experimenter during each trial of a session. An antecedent was scored as correct if the experimenter presented the target question specified on the data sheet for the trial in a clear voice and with the appropriate prompt type and prompt delay. Clear voice was defined as understandable to the independent observer. Appropriate prompt type was the correct tact or echoic prompt for the preceding question following the designated delay. An antecedent was scored as incorrect if the experimenter presented the wrong target question specified on the data sheet for the trial, presented the correct target question in an unclear voice, presented the wrong tact or echoic prompt, or presented the prompt at the wrong time. A consequence was scored as correct if the experimenter presented a reinforcer within 2 s of a correct response emitted by the participant or if an error-correction procedure followed an instance of an incorrect response. Treatment integrity was calculated on a trial-by-trial basis for both antecedents and consequences by dividing the number of trials with correct antecedents or consequences by the number of correct trials plus incorrect trials within each block and converting that number to a percentage. Percentages for correct antecedents across participants ranged from 99.8% to 100%. Percentages for correct consequences across all participants were 100%.

Design

Two concurrent two-tier multielement designs were used to evaluate the relative effects of echoic and tact prompts to teach intraverbal responses (Cooper et al., 2007). The effects of the two teaching conditions (vocal and picture) were compared with baseline in a multiple baseline design across participants (Baer, Wolf, & Risley, 1968). Finally, the effects of exposure to a history of reinforcement for responses to a particular prompt form were evaluated using a reversal design.

Preference Assessment and Reinforcement

We interviewed parents or caregivers to obtain a pool of potential reinforcers. Prior to

each session, each participant was shown a selection of potential reinforcers and asked to select the one that he wanted. The first item that a participant touched or labeled was identified by the experimenter as the potential reinforcer for session participation. To approximate natural learning experiences, correct intraverbal responses were followed by contingent praise (e.g., "great job!") only. After completion of each session, the participant was given the chosen toy or edible item independent of performance during the session.

Procedure

Stimulus probes and baseline. Prior to the study, stimulus probes were completed to ensure that the participants could respond to the echoic and tact prompts used in later training conditions. All pictures selected for use during the tact prompt condition and all vocal models selected for use during the echoic prompt condition were tacted and echoed by all participants. The experimenter provided no programmed consequences during the stimulus probe trials. Stimulus sets were assigned randomly to their respective prompt conditions across participants and experimental phases.

During baseline, participants were asked target questions that were later trained in the preexposure comparison. The target questions were asked in the absence of prompts in an unsystematic fashion consisting of nine-trial blocks. Three target questions were asked three times in a nine-trial block, with no target question asked more than once consecutively. Baseline target questions were presented in the absence of programmed consequences; however, to ensure motivation to respond to the experimenter's questions, a familiar question was asked (e.g., "What's your name?"; "What's your favorite color?"; "Who's your teacher?") after every three trials of target questions (Mace et al., 1988), and praise was delivered after all responses to these questions, regardless of accuracy. All baseline questions were completed during the first session for each participant. No prompting or correction was ever needed

because participants responded accurately to all familiar questions.

Preexposure comparison. This condition assessed, via the total number of trials to criterion, which prompt type transferred control from the tact or echoic prompt to the verbal stimulus (i.e., the question asked by the experimenter) in fewer trials. Participants were taught intraverbal responses to two three-question sets (i.e., three via echoic prompting and three via tact prompting) from the baseline condition. A progressive prompt-delay procedure (Touchette, 1971) was used to fade the tact and echoic prompts systematically. Each session consisted of an average of four to six nine-trial blocks across all conditions. During tact prompt sessions, the tact prompt initially was given immediately after the presentation of the vocal target question (0-s delay). For example, the experimenter presented a picture of a cat immediately after asking, "What is chat?" Subsequently, the delay from the question to the prompt was increased gradually in 1-s increments (Clark & Green, 2004) up to a maximum of 4 s, with a final phase consisting of no prompt. The response was scored as incorrect if no response was given within 5 s of the question during this phase. The experimenter delivered praise (e.g., "good job!") contingent on correct responses after each prescribed prompt and for independent correct responses before a prompt was delivered. Following incorrect or no response to a target question, a correction procedure was implemented. The experimenter removed any materials present, paused for 2 s, and immediately re-presented the target question with a full prompt (no delay). The criterion to increase prompt delays was two consecutive blocks with 89% accuracy. If the participant produced three consecutive incorrect answers or failed to respond following the presentation of three consecutive questions, the prompt delay returned to the previous level. The participant was again required to complete two consecutive blocks with 89% accuracy or higher before

progressing to the next prompt level. The criteria for progression and regression of prompt delays remained consistent across conditions and participants.

In the echoic prompting sessions, the experimenter used the same progressive prompt-delay procedure as described above. The verbal stimulus (i.e., question) was presented, and an echoic prompt (i.e., vocal model) was provided. For example, in a 0-s delay, the experimenter presented a target question by asking, "What is lune?" and immediately provided the vocal model "moon." Criteria to progress and to regress prompt levels were the same as described above.

Mastery criterion for the preexposure comparison phase was reached when participants responded correctly in the absence of prompts on 89% of trials (eight of nine) or higher for two consecutive nine-trial blocks. This criterion was held constant across participants. Following mastery of the first three-question set with one of the prompt types (e.g., tact), additional blocks of the mastered three-question set were performed following every session of training on the unmastered three-question set (e.g., echoic) to control for unequal exposure to one prompt type over the other. During control blocks on the mastered three-question set, the number of prompts and reinforcement delivered within the unmastered set was yoked to the trials within the mastered three-question set. For example, if the participant required two prompts for the three-question set using echoic prompts, then the experimenter delivered two prompts within the next nine trials of the three-question set that had been taught using tact prompts. If errors occurred within the nine trials of the mastered three-question set such that more prompts were required than was programmed by yoking, the difference was added to the next nine trials, and so on. Errors that occurred during yoked trials underwent the correction procedure described above with the prompt type used during initial training sessions. The yoking strategy ensured that the

number of prompted trials and reinforcement for responding to the prompts remained equivalent for each set across prompt types throughout the preexposure condition.

Exposure training. This condition provided increased exposure (history) to one of the two prompt types evaluated during the preexposure comparison. Participants underwent additional training using only the prompting method (echoic or tact) that required more trials to meet mastery criteria for intraverbal responses during the previous preexposure comparison. For example, if a participant required fewer trials to reach mastery with echoic prompts than with tact prompts, tact prompts were used to teach a new three-question set during additional training sessions. The same procedures described in the preexposure comparison were used. Exposure training with a single prompt type continued until participants met the criterion for four (new) three-question sets.

Postexposure comparisons. Postexposure comparisons were conducted to evaluate the influence of increased exposure to a single prompt type to teach new intraverbal responses. We compared acquisition associated with vocal and picture prompts after exposure training. Procedures were identical to those in the preexposure comparison. The experimenter taught intraverbal responses to three new target questions via echoic prompts and to three new target questions via tact prompts. Mastery criterion was identical to that in the preexposure comparison.

RESULTS

Figure 1 shows the percentage of independent correct intraverbal responses across nine-trial blocks for David and Kevin during baseline preexposure and postexposure comparisons. Data from the exposure training are not shown. Neither David nor Kevin answered any questions correctly during baseline. During the preexposure comparison, David met criterion following training with echoic prompts in 12

blocks (108 trials). He met criterion with tact prompts in 13 blocks (117 trials). Following exposure training with tact prompts, David mastered the intraverbal responses in the first postexposure comparison in fewer trials with tact prompts (12 blocks or 108 trials) than with echoic prompts (20 blocks or 180 trials). Next, he received exposure training with echoic prompts for four additional question sets (data not shown). In the final postexposure comparison, he met criterion with echoic prompts in 15 blocks (135 trials) compared to 20 blocks (180 trials) with tact prompts.

During the preexposure comparison, Kevin met criterion with echoic prompts in 17 blocks (153 trials) compared to 27 blocks (243 trials) with tact prompts. After exposure training with tact prompts, he met criterion with the echoic prompts in eight blocks (72 trials) compared to 14 blocks (126 trials) with tact prompts. He then received additional exposure training sessions with four new three-question sets using tact prompts because no reversal in relative acquisition rate was demonstrated following the first exposure training. The number of three-question sets selected for the additional exposure was kept the same to maintain consistency in the number of exemplars included in exposure conditions. Following the completion of this additional exposure condition, Kevin met criterion in a second comparison in 10 blocks (90 trials) with tact prompts compared to 12 blocks (108 trials) with echoic prompts. Final exposure training using echoic prompts followed the first postexposure comparison. The echoic exposure training included eight total three-question intraverbal sets to match the number of exposure training sets taught via tact prompts during the first postexposure comparison. Kevin mastered the intraverbal responses in five blocks (45 trials) with echoic prompts and seven blocks (63 trials) with tact prompts.

Figure 1 also shows the percentage of independent correct responses across nine-trial blocks for Adam and Chasin during baseline,

Figure 1. Percentage of independent correct responses across acquisition blocks for David, Kevin, Adam, and Chasin. Broken vertical line in Kevin's data indicates additional exposure training.

preexposure, and postexposure comparisons. Neither Adam nor Chasin answered any questions correctly during baseline. During the preexposure comparison, Adam met criterion following training in six blocks (54 trials) with echoic prompts compared to nine blocks (81 trials) with tact prompts. Following exposure training with tact prompts, he reached criterion in nine blocks (81 trials) with the tact prompts and in 12 blocks (108 trials) with echoic prompts during the first postexposure comparison. Following the second exposure condition with echoic prompts, he met the criterion in eight blocks (72 trials) with echoic prompts compared to nine blocks (81 trials) with tact prompts during the second postexposure comparison.

In the preexposure comparison, Chasin acquired the intraverbal responses in fewer blocks with the tact prompts (10 blocks or 90 trials) than with the echoic prompts (18 blocks or 162 trials). After exposure training with echoic prompts, he mastered the intraverbal responses in six blocks (54 trials) with echoic prompts and eight blocks (72 trials) with tact prompts. Finally, following the second exposure training with tact prompts, he acquired the intraverbal responses in seven blocks (63 trials) with tact prompts and in 11 blocks (99 trials) with echoic prompts.

DISCUSSION

Transfer-of-stimulus-control and fading procedures were successful in teaching French to English intraverbals to typically developing children. Most interestingly, results suggested that proximal exposure to specific prompt types influenced the relative acquisition rates of intraverbal responses. Specifically, all participants required fewer trials to acquire new intraverbal responses with the prompt method that had been used most recently compared to a prompt method that had not been used recently. These results replicate previous research on intraverbal behavior (e.g., Goldsmith

et al., 2006; Ingvarsson et al., 2007; Partington & Bailey, 1993) by demonstrating the effectiveness of tact and echoic prompts and a progressive prompt-delay procedure for teaching intraverbal responses. These findings also suggest that results of previous studies comparing different prompting methods might be understood without appealing to characteristics of the stimulus properties of the prompts or to procedural differences among the studies.

These results are consistent with some prior research on the effects of immediate reinforcement history (e.g., LeFrancois & Metzger, 1993; St. Peter Pipkin & Vollmer, 2009). Proximal reinforcement history with a particular prompt type may function to establish differential degrees of stimulus control. We can be certain that the tact and echoic prompts exerted control over responding to some degree for all participants prior to exposure training, because all participants responded accurately to them during stimulus probes. The difference in acquisition rates across the two prompt types appears to be a result of differences in the degree of stimulus control established during exposure conditions. Correlation with reinforcement during exposure conditions may have produced differential control by the stimulus properties of echoic and tact prompts during postexposure comparison conditions. That is, the degree to which the different prompts were more or less proximally correlated with reinforcement could have influenced the likelihood of responding to them. This difference in response likelihood may ultimately have affected the speed with which stimulus control was transferred to the verbal stimulus.

However, these results are preliminary, and clinical decisions should be considered carefully until these findings are replicated further in controlled studies. Although we believe the current research design and methodology provide a viable approach for studying the effects of reinforcement history on the acquisition of verbal behavior, potential limitations should be discussed. A notable limitation to any

study that evaluates history of reinforcement is the lack of control over the extraexperimental history that takes place during the course of the study (Wanchisen & Tatham, 1991). It is impossible to know whether contact with content related to the experimental stimuli was controlled completely. Second, preexposure condition data were used as a basis from which we could evaluate attempts to influence the participants' experimental histories (Wanchisen, 1990). Although we selected participants based on assumed minimal prompt histories, their preexperimental exposure to these prompting procedures was unknown and may have influenced the results of the preexposure condition. An additional possible limitation could be the differing forms of praise subjects received after correct responses (e.g., "good job!" vs. "that's right!") and the differing forms of error correction they received after incorrect responses (e.g., "no" vs. "try again"), because there were no formal assessments to evaluate their effectiveness prior to the beginning of the study. Finally, because we compared only two sets of intraverbals during baseline, it is possible that subsequent comparisons would not have yielded the same results. Future research should compare several sets of intraverbal responses systematically prior to implementing the exposure condition.

Additional research should replicate these methods using children with learning disabilities with whom echoic and tact prompts are used more frequently. Should such an extension yield similar results, practitioners who work with children with developmental disabilities may select prompt types based on the children's preestablished history of reinforcement. Practitioners who are becoming newly acquainted with a client or student may benefit by obtaining information about that individual's history of successes or failures with particular prompting methods before considering which methods to use with that individual. However, if such information is unavailable, it may be possible to create a reinforcement history with a

method that is adapted to the individual's learning environment. For example, when vocal prompts are considered distracting to other learners in the environment, a practitioner may select an alternative prompting method (e.g., tact or textual) and establish a reinforcement history with that method.

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