Enhancing Instruction via Instructive Feedback for a Child With Autism Using a Speech-Generating Device

Christopher A. Tullis¹ · Videsha Marya² ·
M. Alice Shillingsburg^{3,4}

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Abstract Instructive feedback (IF) is a procedure in which secondary targets are presented to a learner during instruction for primary skills. Previous research has demonstrated that students with autism spectrum disorder (ASD) may acquire at least a portion of skills presented via IF. Although it is a promising instructional methodology for learners with ASD, few studies focus on learners who use an augmentative device for communication purposes. The purpose of the current investigation was to extend the IF literature related to students with ASD who use communication devices. Across all target skills, IF resulted in the acquisition of at least a portion of secondary targets without explicit teaching.

Keywords autism spectrum disorder · instructive feedback · speech-generating device

Delays in language development are commonly associated with autism spectrum disorder (ASD; American Psychiatric Association, 2013). Recent studies estimate that approximately 26%–29% of people with ASD fail to acquire functional vocal speech (Rose, Trembath, Keen, & Paynter, 2016). An initial lack of vocal speech may result in many people with ASD being candidates for an augmentative or alternative communication (AAC) device (Ganz, 2014). AAC refers to a variety of supports that

✉ Christopher A. Tullis
ctullis2@gsu.edu

¹ Department of Educational Psychology, Special Education, and Communication Disorders, Georgia State University, PO Box 3965, Atlanta, GA 30302, USA

² The Marcus Autism Center, Atlanta, GA, USA

³ The Marcus Autism Center and Emory School of Medicine, Atlanta, GA, USA

⁴ Present address: The May Institute, Randolph, MA, USA

supplement or replace a learner's vocal speech through aided (e.g., speech-generating device [SGD]) or unaided (e.g., gestures, manual signs) means (Schlosser & Koul, 2015).

Many studies that evaluated the use of AAC devices with people with ASD focus on teaching mands rather than complex responses, such as identifying problem situations and suggesting potential solutions (Schlosser & Koul, 2015). It is important to teach more complex responses to people who use AAC devices because advanced communication is necessary for greater independence (Ganz, 2014). People with ASD who use AAC devices (aided and unaided) frequently experience overall academic, social, and vocational difficulties that may be related to the lack of more complex communication (Ganz, 2014). One instance of the type of advanced communication that may be necessary to access a number of environments independently is the repertoire of identifying and explaining problematic situations (e.g., verbal problem solving). For example, one skill that employers have reported as limited in people with ASD in work settings is the ability to identify when assistance is needed from a supervisor or coworker (Agran, Hughes, Thoma, & Scott, 2016). In this instance, the learner is required to identify a problem situation and verbally report why the situation needs to be resolved. In the overall population of people with ASD, verbal problem solving has been reported as a common skill deficit, and research on effective and efficient methods for teaching more complex communication skills, such as verbal problem solving, is warranted (Alderson-Day, 2014). One procedure that has been shown to increase instructional efficiency with individuals with ASD is instructive feedback (IF; Nottingham, Vladescu, Kodak, & Kisamore, 2017).

IF is an instructional strategy where secondary targets are presented during the consequent event of a learning trial, and learners are not required to respond to the secondary targets (Werts, Wolery, Holcombe, & Gast, 1995). For example, if an instructor is teaching tacts (e.g., scissors), he or she may present information related to the function of the target stimulus as IF (e.g., cutting), which may enhance instructional efficiency such that learners acquire secondary targets without the addition of programmed consequences for responding (Werts et al., 1995). In this instance, "cutting" would serve as the secondary target response to "What can you cut with?" which is not directly taught.

Although IF research with participants with ASD is promising (Nottingham, Vladescu, & Kodak, 2015), the extent to which IF methodology is effective for learners with ASD who rely on an AAC device for communicative purposes is unclear (Schlosser & Koul, 2015). In addition, the overall literature provides sufficient support for the inclusion of IF to teach one-word utterances but limited support for more complex verbal behavior that may be necessary for longer utterances (e.g., Nottingham et al., 2017; Vladescu & Kodak, 2013). Delmolino, Hansford, Bamond, Fiske, and LaRue (2013) investigated the effects of IF on longer vocal utterances for three participants diagnosed with ASD. One participant acquired secondary targets, and the remaining two required direct teaching to acquire secondary targets. Although the remaining two participants acquired secondary targets in this condition, the effects on other untrained secondary utterances was not demonstrated.

In instances where more complex verbal behavior (e.g., longer utterances) is the focus, only some of the participants acquired secondary targets after IF was introduced (e.g., Delmolino et al., 2013), and the effects of procedures for nonresponders to IF methodologies are not fully investigated. In one exception, Tullis, Frampton, Delfs, and

Shillingsburg (2017) taught three participants with ASD to receptively identify problem depictions (primary target) and provide the corresponding explanations (secondary target presented as IF). Two participants required multiple-exemplar instruction for one set of problem depictions before acquiring problem explanations via IF for a subsequent set. One participant acquired all explanations with IF alone. In comparison to previous IF investigations (e.g., Delmolino et al., 2013; Vladescu & Kodak, 2013) where single-word utterances were targeted, Tullis et al. (2017) taught 13- to 14-word utterances and evaluated procedures for participants who do not initially respond to the implementation of IF. One way IF methodology may be altered to teach more complex verbal responding to a person who types verbal responses on an SGD may be to present textual prompts that correspond with the correct typed response as IF. As such, the purpose of the current investigation was to extend the IF literature related to learners with ASD replicating the Tullis et al. investigation with a child with ASD who also used an SGD.

Method

Setting, Participant, and Materials

James was a 6-year-old male diagnosed with ASD and dyspraxia. Prior to the study, James had 9 months of intensive intervention (2 hr per day, 5 days a week) that did not include programming that incorporated IF procedures. The Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008) was administered, and James was assessed at a VB-MAPP Milestones Level 2 with a number of skills emerging in Level 3. On the VB-MAPP Barriers Assessment, James scored high in defective echoic and articulation domains. His use of vocalizations was extremely limited. On the Woodcock–Johnson IV battery (Schrank, Mather, & McGrew, 2014), James scored above his age equivalent (AE) in reading (AE = 7:1; standard score [SS] = 112) and within his age equivalent in academic skills (AE = 6:3; SS = 95), passage comprehension (AE = 6:7; SS = 102), sentence-reading fluency (AE = 6:2; SS = 95), and editing (AE = 6:3; SS = 98). Deficits were identified in applied problems (AE = 3:10; SS = 60), spelling (AE = 5:9; SS = 87), and basic writing skills (AE = 5:11; SS = 88).

James communicated using a first-generation Apple iPad Air that had TouchChat® with the WordPower program (www.touchchatapp.com) installed. The device emitted a digitized speech output. He was fluent in device navigation and engaged in both iconic and topographical responding (i.e., typing) by accessing the keyboard function within the app. All sessions were conducted in James's classroom within a language clinic providing behavioral interventions for learners with ASD. Typical materials that were unrelated to the study were present at and around the table (e.g., books). Learners that were nonparticipants in the current investigation were seated at nearby tables but did not interact with the therapist or James during study sessions.

Stimuli consisted of twenty-seven 7.62 cm × 7.62 cm laminated cards. Nine cards depicted a problem situation (e.g., a broken pencil), and the remaining cards depicted matched distractors where no problem was present (e.g., a pencil with a sharpened tip). All distractors were specific to the target problem stimulus card and were only presented with the corresponding problem stimulus card. Stimuli were divided into

three sets with three problem scenarios in each set and six matched distractors (two per target problem). Stimulus sets are depicted in Table 1.

Experimental Design, Operational Definitions, and Data Collection

A multiple-probe design across stimulus sets was used to determine if a functional relation was present (Gast & Ledford, 2014). Correct responding on the primary target, termed *problem selection*, was defined as the participant independently pointing to or handing the picture that depicted the problem situation to the therapist within 3 s of the therapist asking (e.g., “Point to the problem.”). Incorrect responding was defined as selecting or pointing to one of the distractor stimulus cards. Correct responding on the secondary target, termed *problem explanation*, was defined as independently typing words on the SGD display within 3 s of the initial direction such that the voice output of the SGD emitted the functionally correct output that corresponded with the trained problem solution (e.g., “Because cold.”). Incorrect responding was defined as typing words on the SGD that did not correspond with the trained problem solution. Incorrect spelling of target words was accepted if the vocal output corresponded with the correct response once the voice output was activated (e.g., “where” instead of “wear” would be accepted but “clod” instead of “cold” would not).

Interobserver Agreement (IOA) and Implementation Fidelity

IOA data were collected with paper-and-pencil recording by a trained observer. The observer scored sessions in vivo in a room that was separate from the therapist (the

Table 1 Instructive Feedback (IF) textual and picture stimuli

Problem stimuli	Matched distractor	IF
Sand/rocks on a slide	No sand/rocks on a slide Small amount of sand on a slide	“Because can’t go down.”
Person without a jacket and snow on the ground	Person with a coat on and snow on ground Person with a hooded sweatshirt on and snow on the ground	“Because it’s cold.”
Bowl on top of a cabinet	Bowl on the bottom shelf of a cabinet Bowl on the middle shelf of a cabinet	“Because can’t reach
Batteries missing from a toy	Batteries in the battery compartment of a toy Batteries next to a toy	“Because can’t work.”
Pencil with a broken tip	Pencil with a sharp tip Pencil with a dull tip	“Because can’t write.”
Spilled milk	Cup full of milk Cup half full of milk	“Because can’t drink.”
Empty ChapStick	ChapStick full and visible above applicator ChapStick full and not visible above applicator	“Because can’t use.”
A deflated basketball	Inflated basketball (regulation size) Inflated basketball (miniature)	“Because can’t throw it.”
An empty pool	Pool full of water with a blue tint Pool full of water with a green tint	“Because can’t swim.”

primary data collector). An agreement was determined if both data collectors indicated the occurrence of a correct or incorrect response during the same trial. IOA was calculated using point-by-point agreement for 63% of all baseline and intervention sessions and was 100%. Implementation fidelity was collected via a checklist on the stimulus presentation, delivery of prompts and vocal praise, and IF presentation in each trial for 37% of sessions. Implementation fidelity was 100% across all sessions.

Prerequisite Training

Prior to the initiation of baseline conditions, all unknown word spellings in each explanation were taught. Explanations consisted of three- to four-word phrases with 17 different individual words in total (see Table 1 for specific words). Prior to initiating teaching sessions, three baseline probes were conducted to assess spelling of the 17 words. The therapist delivered the instruction “Spell [word]” and allowed 3 s for James to respond. No programmed consequences were in place for either correct or incorrect responding. During teaching sessions, the therapist delivered the instruction “Spell [word]” and used a textual prompt (i.e., printed word) delivered via simultaneous prompting to evoke the response. If James did not respond to the textual prompt, gestural prompts were delivered (i.e., pointing to each letter on the display). After prompted responses, an independent opportunity to respond was delivered. Praise and tokens, a classroom-wide system that was used for all of James’s programming, were provided for both independent and prompted responses, and delivery of both were identical to what was found in his typical educational setting. If James responded incorrectly, no programmed consequences were delivered and the trial was terminated. Trials were interspersed throughout typical daily instructional sessions. Mastery was defined as 3 consecutive days with 100% correct responding on the preteaching probe.

Baseline

During baseline, the therapist presented an array of three stimulus cards, one depicting a problem and two matched distractors, and asked, “Which one is the problem?” (the primary target). All stimulus arrays were presented in semirandom order, and there were no programmed consequences for correct or incorrect responses. A problem-explanation probe was conducted (e.g., “Why is this a problem?”) immediately after his selection, regardless of correct or incorrect responding. All baseline sessions were three trials, and James’s SGD was present and available in all sessions.

Intervention

Problem-selection training and IF All procedures were identical to baseline with the following exceptions. If James made a correct response to the primary target (i.e., pointed to the problem), praise and IF were delivered. IF consisted of an explanation of the related problem (e.g., “This is a problem because you can’t use the ChapStick.”) and was presented via text (a typed phrase on a 10.16 cm × 15.24 cm index card) and vocal modalities. IF was presented this way to match both the icons on the SGD screen (text) and the SGD vocal output (vocal). If the participant responded incorrectly, the therapist pointed to the correct stimulus, rearranged the stimulus cards, and then asked,

“Which one is the problem?” If James did not identify the correct stimulus, a physical prompt was provided and IF was delivered. Across all correct independent trials, vocal praise was delivered, followed by IF.

Secondary target probes Following two teaching sessions, a secondary target probe was conducted concurrent with presentation of the primary target stimuli. Incorrect problem-selection responses were corrected as outlined previously, but no IF was provided following a selection. Rather, the therapist asked, “Why is this a problem?” No praise or feedback was provided following explanation responses. The criterion for mastery was 80% correct for both problem identification and explanations on one probe session.

Problem-explanation training If James did not meet mastery for the secondary targets after two consecutive probes, problem-explanation training was introduced during primary target instruction. All procedures were consistent with those outlined previously, with the following exception. After James correctly selected the correct primary target stimulus, the therapist asked, “Why is this a problem?” and prompted the response via textual and vocal prompts at a 0-s delay. If James made the corresponding response on his SGD, praise was provided.

Follow-up Following mastery, secondary probes (described previously) were continued to assess the extent to which James continued to engage in the response after mastery. Follow-up probes were initiated 1–2 days postmastery and were conducted after every two teaching sessions. Procedures were identical to baseline conditions.

Results and Discussion

In the current investigation, we replicated and extended previous results from Tullis et al. (2017) by demonstrating similar acquisition and evaluated the effects of presenting IF via text on the secondary target acquisition of a participant with ASD who used an SGD instead of vocalizations to communicate (see Fig. 1). Correct problem selection occurred following direct teaching for all sets, and some problem explanations from each set were acquired without explicit teaching. In Set 1, an increase in correct problem explanations was observed; however, responding to one secondary target was consistently incorrect due to a spelling error (i.e., “clod” instead of “cold”). Although correct responding to this secondary target was on an increasing trend, the decision was made to directly teach the secondary target response due to the spelling error. We chose to do explanation training instead of doing spelling booster sessions because direct teaching involved textual prompts that were identical to those used during spelling training. Once direct teaching was implemented (i.e., explanation training with textual prompts), James correctly spelled the target word and met the mastery criterion. Overall, James was directly taught 10 targets, whereas 9 emerged without direct teaching. These gains persisted once intervention was withdrawn across both stimulus sets that were evaluated during follow-up.

These data extend the previous work in IF and learners with ASD in three meaningful ways. First, previous studies focused on learners who had a vocal repertoire (e.g.,

Vladescu & Kodak, 2013). Many people with ASD fail to develop intelligible vocalizations (Rose et al., 2016), and procedures focusing on increasing the efficiency of teaching people with ASD with AAC devices are limited in the literature (Schlosser & Koul, 2015). Further research in this area is necessary, but the current study is one example of a potential methodology for enhancing the efficiency of instruction for learners with AAC devices. Second, current procedures for teaching AAC device use are mainly focused on teaching mands (Schlosser & Koul, 2015). Although preliminary, the current procedures present one way of teaching potentially more complex verbal utterances to people with ASD that use AAC devices, but not necessarily a way of increasing mean length of utterance (MLU). Future research may be needed to determine if MLU impacts the complexity of verbal responses learned during IF procedures. Last, Nottingham et al. (2015) noted that one limitation of the IF literature as it relates to learners with ASD is the lack of studies where maintenance was documented. In the current study, follow-up data were collected to demonstrate the occurrence of both primary and secondary target skills after teaching was concluded. Although these responses continued to occur, these data were collected over a short period of time (range 1–4 days), and future research may benefit from demonstrating the durability of observed gains over longer durations (i.e., maintenance). A similar limitation may be the somewhat arbitrary nature of the stimuli selected for teaching.

Fig. 1 Results for James. Percentages of correct problem selections are represented by the filled diamonds, and correct explanations are represented by the open circles.

Problem depictions were selected based on scenarios where a child may need to engage in specific speaker behavior (i.e., tact a problem, and why it is so), but it is unknown if these were analogous to situations that the learner encountered outside of experimental sessions. Future research may benefit from determining what naturalistic stimuli learners in nonexperimental contexts may encounter and including those situations in experimental arrangements.

Nottingham et al. (2015), as well as Werts et al. (1995), offered several mechanisms that may be responsible for the effectiveness of IF procedures. These mechanisms still remain somewhat elusive, but data from the current investigation may lend support to the suggested importance of an imitative repertoire (Delmolino et al., 2013). Prior to this investigation, James learned to type on his SGD and to activate the sound output. Although the specific teaching procedures are not known, procedures may have included modeling, which resulted in a generalized imitative repertoire related to environmental stimuli, which was in part supported by a score of 9 on the imitation subscale of the VB-MAPP and no barriers in defective imitation or listener behavior on the Barriers Assessment (Sundberg, 2008). During the investigation, imitation of textual IF was not observed, but this may have been the result of the absence of the instructor cue (e.g., “Why is this a problem?”). Future researchers may benefit from measuring collateral behavior to determine if imitation (e.g., lip movements) occurs during teaching. Similarly, procedures were conducted in James’s typical instructional environment, where a number of academic behaviors resulted in reinforcement (e.g., attending, responding to instruction), which may have impacted the level at which he responded to IF stimuli (i.e., the history of reinforcement for responding in some manner to environmental stimuli was well established). Additional research is necessary to further elucidate these variables in an effort to provide a full account of the mechanism underlying the effectiveness of IF procedures. Researchers might vary the secondary probe and teaching context by altering the instructors or physical aspects of the context in which probes are conducted, as well as test the effectiveness of IF procedures with learners that have weak imitative repertoires.

The results of the current investigation are promising, and these data may lead to meaningful extensions that further enhance both IF and AAC methodologies for people with ASD. For example, researchers might attempt to teach problem identification and explanations in more naturally occurring contexts. Problem solving as a response chain may be under the momentary control of motivating operations (Laraway, Snyckerski, Michael, & Poling, 2003) that establish a specific stimulus change as a reinforcer and evoke behavior or classes of behavior that have resulted in the stimulus change previously (D’Zurilla & Goldfried, 1971). In the current investigation, explanations were not taught under the relevant environmental arrangements that may evoke behavior that is consistent with outcomes that can be classified as a solution. Future research may be necessary to determine the extent to which the current procedures may generalize to more naturalistic problem-solving contexts.

Future research with SGDs and IF might also consider the role vocal and textual IF have on secondary target responding. Anecdotally, James attempted to vocalize more outside of research sessions, and during research sessions he attempted to vocalize some corresponding phonemes during secondary target probes. Although delivering IF in this manner was done in an effort to match the vocal output of the SGD and the letter forms on the SGD screen, the effects of delivering both stimuli is unclear. Previous

research documented an increase in imitation during IF (e.g., Vladescu & Kodak, 2013), but these participants already engaged in vocal imitation. Future research is needed to determine if delivering both vocal and textual IF results in an increase in vocal attempts or approximations for learners that use SGDs. Similarly, the role that each type of prompt had on skill acquisition is unclear in this investigation. Results from Vedora, Meunier, and Mackay (2009) and Finkel and Williams (2001) support the use of textual prompts over vocal prompts in teaching intraverbal responding, but participants in both studies presented with at least a basic echoic repertoire. In the current investigation, James did not have a developed echoic repertoire, but future investigations may benefit from comparing the effectiveness of echoic and textual prompts in teaching secondary targets.

Additional research is warranted on the efficiency of IF for learners with, and without, AAC devices. The current study did demonstrate that IF procedures could result in more targets learned in presumably less time, but quantifying efficiency in terms of the raw number of targets learned lacks precision in some respects. One such way of quantifying the efficiency of a procedure is to calculate the learning rate (Skinner, 2008, 2010). Yaw et al. (2014) suggest further refinement beyond calculating learning rate for comparison purposes. A more refined analysis of efficiency may entail calculating mean learning time per target, which allows for consideration of overall teaching time. Research using a metric such as a learning rate or mean teaching time per target might provide useful information about how much exposure to IF learners need before secondary targets emerge. This number could be compared to direct teaching for all targets to get a more precise measure of efficiency.

Compliance with Ethical Standards

Conflict of interest The authors have no declared financial conflicts of interest.

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

Informed consent Informed consent was obtained for all individuals in the study.

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