Teaching Problem Explanations Using Instructive Feedback

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Abstract Instructive feedback (IF) is a procedure in which extra information is presented to a participant during the consequence portion of instruction for other skills. Previous research has demonstrated that participants with intellectual disabilities may acquire a portion of non-targeted skills (secondary targets) without explicit instruction when extra information is presented. Previous research has demonstrated that IF has resulted in more efficient instruction for participants with disabilities as a whole. However, few studies have focused on participants with autism spectrum disorders (ASDs). Additionally, the measures of secondary target acquisition in past research have focused solely on discrete responses (e.g., one-word utterances). The current investigation extended the IF literature related to participants with ASD by including longer verbal responses as secondary targets and assessing maintenance for both primary and secondary targets. Across three participants, IF resulted in the acquisition of at least a portion of secondary targets without explicit teaching. For two participants, additional instruction was required before IF resulted in acquisition of secondary targets. Across all three participants, gains observed for both primary and secondary targets in intervention were maintained.

Keywords Autism spectrum disorder · Discrete-trial-teaching · Explanations · Instructive feedback

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Instructive feedback (IF) is an educational strategy that involves the presentation of secondary targets or non-targeted stimuli during the consequent events of an instructional trial. Participants are not required to respond to the IF, and programmed contingencies are not in place for responses to the secondary target (Werts, Wolery, Holcombe, & Gast, 1995). For example, during the implementation of a teaching trial in which the participant must respond with a tact of the object (e.g., chair), the IF may consist of a feature of that item (e.g., “a chair has a back and four legs”). The purpose of IF is to enhance the efficiency of instruction (Werts et al.). Previous investigations of IF have demonstrated marked improvement in the acquisition of at least some secondary targets for participants from preschool into adulthood (Werts et al.). These findings have been consistent across one-to-one teaching (Carroll & Kodak, 2015; Reichow & Wolery, 2011; Vladescu & Kodak, 2013) and small group instruction (Whalen, Schuster, & Hemmeter, 1996).

Although IF has been demonstrated to be an effective strategy with participants with intellectual disability, a significantly smaller number of investigations have specifically investigated the utility of IF with participants with autism spectrum disorder (ASD; Werts et al., 1995). In one example of the application of IF to participants with ASD, Reichow and Wolery (2011) compared the effects of progressive prompt delay (PPD) with and without IF on the picture and sight word naming of four participants with ASD. Across all four participants, PPD with IF resulted in a greater number of skills acquired, in comparison to PPD alone. One limitation to the Reichow and Wolery investigation was the point at which participants acquired secondary targets was not evaluated. Additionally, only one-word responses were required during probes for secondary target acquisition.

Vladescu and Kodak (2013) further extended the IF literature in an investigation comparing delivery of secondary targets during antecedent events, with expansion IF on the acquisition of one-word fill-in-the-blank responses with four participants with autism spectrum disorder (ASD) aged 3 to 6. Similar to previously reported outcomes for participants with ASD in the IF literature (e.g., Reichow & Wolery, 2011), three out of the four participants acquired the secondary targets without explicit instruction. Although the Vladescu and Kodak study was a meaningful extension of the IF literature, the probes measuring the emergence of secondary targets only tested for the occurrence of one-word responses (i.e., the word required to complete a fill-in the blank statement) and not the full statement.

Delmolino, Hansford, Bamond, Fiske, and LaRue (2013) investigated the effects of IF on intraverbal responding (i.e., answering questions) with four participants diagnosed with ASD aged 5 to 13. In experiment one, expansion IF was delivered only after a correct response to the primary target stimuli. Two participants demonstrated mastery of a portion of the secondary targets without explicit teaching, and the remaining two did not acquire any secondary targets after IF was implemented. Although the effects of the Delmolino et al. investigation were somewhat positive, the implementation of expansion IF for participants with ASD warrants further investigation. In comparison to the Reichow and Wolery (2011) and Vladescu and Kodak (2013) investigations, Delmolino et al. measured longer intraverbal responses during secondary target probes, and not discrete vocal utterances (e.g., tacts), which may account for the delay in secondary target acquisition for two of the participants.

Carroll and Kodak (2015) further extended the research on IF related to participants with ASD by implementing IF procedures to teach variable responding for intraverbal lists. These results were novel in that they were the first to demonstrate the utility of IF to increase response variability, but the authors did not explicitly measure the acquisition of secondary targets. Although variability of intraverbal responding (e.g., lists of animals) was measured, these responses may remain relatively low effort in relation to more complex intraverbals involved in conversational speech (Sigafoos, Roberts, Kerr, Couzens, & Baglioni, 1994; Stone, & Caro-Martinez, 1990). For some participants with ASD, acquisition of discrete utterances may be more easily acquired than longer intraverbal responses (Charlop-Christy & Kelso, 2003).

Across studies where individuals with ASD are the participants, evidence of generalization or maintenance of skills after IF is limited (Nottingham et al., 2015). For example, Carroll and Kodak (2015) were successful in teaching intraverbal lists with varying elements, but the extent to which these generalized to a natural context or the durability of variable responding over time was absent. Similarly, Loughrey, Betz, Majdalany, and Nicolson (2014) demonstrated skill acquisition of category names after IF with two children with ASD, but how participants used those skills under more natural conditions was not measured, and the extent to which category names persisted over time was not reported. In contrast to previous IF studies focusing on participants with ASD, Reichow and Wolery (2011) demonstrated varied maintenance of skills acquired after IF. Further demonstrations of maintenance and generalization are required to fully determine the efficacy of IF procedures beyond increasing instructional efficiency in a short period of time.

Instructive feedback has been demonstrated to be an effective practice, but the relative paucity of literature with participants with ASD warrants further investigation. With the exception of Delmolino et al. (2013), studies focusing on participants with ASD implement expansion IF that requires a somewhat low-effort response (i.e., single utterance). The measurement of lower effort responses as included in previous studies (e.g., Vladescu & Kodak, 2013) does not allow for further evaluation of longer utterances, which may not emerge after IF (e.g., Delmolino et al.). The lack of emergence of longer utterances after IF may be attributed to deficits in attending, and response effort required for intraverbal responding when compared to other verbal operants such as tacts (Delmolino et al.). In addition to this limitation, only one study demonstrated the maintenance of IF gains over time (Reichow & Wolery, 2011) and the results were variable across participants. The purpose of the current study was to further extend the work on IF for participants with ASD by measuring a longer intraverbal response during secondary target probe sessions and probing for maintenance after skill mastery in both primary and secondary targets.

Method

Setting, Participants, and Materials

All sessions were conducted in the participants' classroom within a language clinic for participants with ASD. The participant and instructor were seated across from one another at a table. Typical classroom materials that were unrelated to the study (e.g.,

books, stimulus cards, toys) were present at and around the table. Children who did not participate in the study were seated at nearby tables but did not interact with the instructor or participants during study sessions.

Table 1 depicts the Milestones, Tact Domain, Echoic Domain, and Barriers Assessment scores for self-stimulatory and hyperactive behavior on the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP™; Sundberg, 2008) for all participants. Zoe was a 7-year-old female diagnosed with ASD and sensory processing disorder who attended the language clinic for 13 months at the start of the study. Samantha was a 6-year-old female with ASD who attended the language clinic for 11 months at the start of the study. Toby was a 7-year-old male with ASD who attended the language clinic for 4 months at the start of the study. All participants had a generalized imitation repertoire, a mean length of utterance (MLU) of at least four words, and engaged in answering “wh” questions. Toby’s Barriers Assessment results indicated moderate levels of self-stimulatory (i.e., hand clasping, clapping) and low levels of hyperactive behavior. Additionally, all participants emitted multiple intraverbals with conditional discriminations; tacts by feature, function, or class with complete sentences; and receptive skills by feature, function, or class based on multiple verbal components.

The stimuli consisted of laminated 7.62 cm in by 7.62 cm stimulus cards. In total, there were 27 stimulus cards. Nine depicted a situation with a problem present (e.g., a toy without batteries). These nine problem situations were distributed across three sets. The remaining 18 stimulus cards consisted of matched distracters where no problem was present (e.g., toy with batteries present and the compartment door closed, toy with batteries present and the battery compartment door open). All distracters were specific to the problem situation (e.g., batteries present vs. batteries missing), assigned to the same set as the target problem situation, and distractor stimuli were only presented with the corresponding problem stimulus. Thus, each set consisted of three target problems and six distracters (two per target problem).

Experimental Design, Operational Definitions, and Data Collection

The functional relation between the independent variable and the dependent variable was evaluated using a multiple-probe design across stimulus sets (Gast & Ledford, 2014). Correct responding on the primary target (“*problem selection*”) was defined as pointing to or giving the primary target from an array of three within 5 s of the therapist

Table 1 Participant characteristics

Participant	Age	Diagnosis	VB-MAPP Milestones score	Tact domain score	Echoic subtest score	Barriers assessment: self-stim.	Barriers assessment: hyperactive
Zoe	7	ASD and sensory processing disorder	71.5	7	40	2	3
Samantha	6	ASD	145	11	90	2	1
Toby	7	ASD	130.5	13	90	1	0

delivered the discriminative stimulus (S^D ; e.g., “Where is the problem?” or “Hand me the problem”). Correct responding on the secondary target (*problem explanation*) was defined as vocally stating the element of the situation that prevents proper function of the device (e.g., “the batteries are missing”) or could cause discomfort to the user (e.g., “sand on the slide”) and the possible outcome (e.g., “so you can’t turn it on,” “it would hurt to go down the slide”). Correct problem explanation responses could include deviations from the IF statement provided by the therapist, as long as the above criteria were met. For example, if the participant was presented with a stimulus card with sand on the slide, and they stated “there’s stuff on the slide, and it may scratch me,” the response was scored as correct. Similarly, the participant may state “I can’t go down the slide, the sand will scratch me!”, and this response was also scored as correct.

Interobserver Agreement

Interobserver agreement (IOA) data were collected with paper and pencil. A trained observer scored the sessions from video or in vivo. An agreement was determined if both data collectors indicated the occurrence of a correct or incorrect response during the same trial. The total number of agreements were divided by the total number of agreements and disagreements, and then multiplied by 100 to yield the IOA coefficient. For Zoe, IOA data were collected on 35.48% of sessions with a mean IOA score of 99.83% (range, 94.44–100%). For Samantha, IOA data were collected on 29.54% of sessions with a mean IOA score of 100%. For Toby, IOA data were collected on 45.45% of sessions with a mean IOA score of 99.44% (range, 83.33–100%).

Baseline

Figure 1 is a visual representation of baseline procedures. During baseline, the therapist placed an array of three stimulus cards in front of the participant and delivered the S^D to choose the correct stimulus. If a correct problem-selection response was emitted, the therapist provided praise, pointed to the picture, and presented a probe for the problem explanation. If the participant emitted an incorrect problem-selection response, no feedback or error correction was provided but the therapist still conducted the problem explanation probe. The probe for the problem explanation consisted of pointing to the stimulus card the participant just selected and presenting the S^D , “Why is this a problem?” Unrelated mastered (i.e., previously acquired) speaker and listener trials (e.g., “Show me your ears, nose, and mouth,” “What do you use to listen?”) were interspersed throughout sessions, and points or tokens were provided for compliance on these mastered demands. All sessions included nine problem-selection trials with three array presentations per problem situation and nine problem explanation trials.

Problem Selection Training and Instructive Feedback

Figure 1 is a visual representation of the procedures implemented during the problem selection and IF phase. Procedures for this phase were similar to baseline with the following changes. Following the presentation of the S^D for problem selection, if the participant engaged in an error or the participant did not respond

Fig. 1 Baseline and problem explanation + IF procedures

within 3 s, error correction was initiated. In error correction, the therapist repeated the S^D and provided a model prompt (i.e., pointed to the portion of the picture that was the problem). Model prompts were selected in coordination with each participant's clinical case manager, as model prompts typically evoked correct responding during daily instruction. If the participant responded correctly to the model prompt, praise was provided. If the participant did not respond correctly to the model prompt, a physical prompt was provided. Following a prompted correct response, the array was rearranged, the S^D was repeated, and another independent response opportunity was provided. If the participant responded correctly either after the initial S^D or following error correction, praise (Samantha) or praise and a token (Zoe and Toby) was provided. Across all trials, IF was delivered following the consequent event for the primary target (see Fig. 1). The IF statements

provided to the participants are included in Table 2. Following two treatment sessions, a probe for the secondary target was conducted. Secondary target probes were conducted after every two treatment sessions and were identical to problem selection probes except that no IF was provided following a selection. Rather, the therapist presented the S^D , “Why is this a problem?” and waited 3–5 s for a response. No praise or feedback was provided following correct/incorrect problem explanation responses. The mastery criteria for Toby and Samantha were three consecutive sessions of 80–100% correct problem selections and one session of 80–100% correct problem explanations on secondary target probes. The mastery criterion for Zoe was three consecutive sessions of 80–100% correct problem selections and two sessions with 80–100% correct problem explanations on secondary target probes. This modification was made for Zoe to account for the delay in acquisition of secondary target information with less intensive teaching procedures.

Problem Explanation Training Figure 2 depicts the procedures implemented during problem-explanation training for Zoe and Samantha. If the participant did not meet the mastery criteria after two secondary target probes, problem-explanation training was implemented during instruction for primary targets. During this modification, all procedures remained the same as outlined previously except the initial S^D for the secondary target was delivered and the problem explanation was vocally prompted with a 0-s delay during teaching for primary targets. Following the occurrence of the prompted secondary target response, praise was provided. For Zoe, the prompt was then delayed 1 s in session 39 to allow her to engage in the response prior to the prompt. Across all participants, if the participant started to vocally emit the problem explanation after the initial S^D , no prompts were provided. All secondary target probe procedures remained consistent with the procedures outlined previously.

Table 2 Instructive feedback statements and picture stimuli

Plush toy with batteries missing	“This is a problem because the batteries are missing so you cannot turn it on.”
Pencil with a broken tip	“This is a problem because the pencil is broken so you cannot write.”
Woman wearing a T-shirt in the snow	“This is a problem because her jacket is missing so she will get cold.”
An empty chap-stick tube	“This is a problem because the chapstick is empty so you cannot put it on your lips.”
Shoe with no laces	“This is a problem because the laces are missing so you cannot tie the shoe.”
Bare feet in the snow	“This is a problem because her shoes are missing so she will get cold.”
Sand on slide	“This is a problem because there’s sand on the slide so you cannot go down.”
A deflated basketball	“This is a problem because the ball is squished so we cannot play.”
An empty pool	“This is a problem because the pool is empty so we cannot swim.”

Fig. 2 Explanation training methods. Instructional modifications for Zoe are denoted with *dashed lines*. Procedures for all other participants are denoted with *solid lines*

Maintenance

Secondary target probes were continued with mastered sets to assess maintenance of problem selection and explanation responding in the absence of IF. Maintenance probes were conducted concurrently with IF probes for the set currently in training.

Results

Figures 3, 4, and 5 depict the results for each participant. For Zoe, baseline levels of primary target responding were elevated for sets 1, 2, and 3, and the secondary target responding was at zero across all stimulus sets. When problem-selection training with IF was introduced in set 1, responding to the primary target increased, while responding to the secondary target stimuli remained at zero levels. Further increases in responding were observed for the primary target when problem explanation training was implemented, but this change did not result in an increase in secondary target responding. When the prompt delay was increased to 1 s, primary target responding remained elevated, and secondary target responding increased to mastery levels. In set 2, an overall increase was observed for the primary target, and an immediate increase was observed for the secondary target once intervention of problem selection training and IF were introduced. These results were replicated in set 3, with the primary target increasing in relation to baseline, and an increase in relation to baseline for the

Fig. 3 Results from Zoe's evaluation. Percentages of correct problem selections are represented by filled circles; percentages of correct problem explanations are represented by open circles. PS + IF Problem selection + IF, PET problem explanation training, PET + PD problem explanation training + prompt delay

Fig. 4 Samantha's evaluation. Percentages of correct problem selections are represented by filled circles; percentages of correct problem explanations are represented by open circles

Fig. 5 Toby's evaluation. Percentages of correct problem selections are represented by *filled circles*; percentages of correct problem explanations are represented by *open circles*

secondary target. Mastery was reached in an average of 15 sessions across sets. Improvements in responding to the primary and secondary targets maintained across set 1 and 2.

For Samantha, baseline levels were elevated across all stimulus sets for the primary target in sets 1, 2, and 3. Zero levels of responding for the secondary target was observed for sets 1 and 2 and near zero levels for set 3. When problem-selection training and IF was introduced in set 1, primary target responding remained elevated, with little variability, but secondary target responding remained at zero levels. Problem-explanation training was implemented for set 1 and correct responses to the secondary targets immediately increased and responding to the primary targets maintained. When problem selection training and IF was introduced in set 2, responding to the primary target stimulus remained elevated and responding for the secondary target increased to mastery levels. In set 3, the same effects on responding to the primary and secondary targets were observed. Mastery was reached in an average of nine sessions across sets after treatment was introduced. During maintenance, responding to both the primary and secondary targets remained elevated in relation to previously observed baseline responding for set 1 and set 2.

During baseline, Toby's responding to the primary targets was also elevated across sets 1, 2, and 3. Some variability was observed in responding to the secondary targets across the sets. When problem selection training and IF were introduced, responding for the primary target increased across sets 1, 2, and 3. Responding for the secondary target also increased across sets 1, 2, and 3. Mastery was reached in an average of seven

sessions across sets after teaching was introduced. Under maintenance conditions for sets 1 and 2, elevated responding persisted.

Discussion

In this investigation, we evaluated the effects of presenting IF during learning trials to teach three children with ASD to receptively identify common problem situations and provide the explanation for why a certain situation presented a problem. One of the three participants (Toby) acquired all secondary targets through instructive feedback. The remaining two participants acquired secondary targets via IF when explanation training for one set of secondary targets was implemented. Responding to non-targeted information maintained for all participants regardless of the presence of more intensive teaching.

These findings are somewhat similar to other investigations, but in these previous reports, participants have required explicit instruction across all teaching stimuli and not on solely one set. For example, Delmolino et al. (2013) found that participants that needed explicit instruction for one secondary target required explicit instruction for the remaining secondary targets. Instructive feedback was effective in part across all participants, but only Toby demonstrated the “free learning” that has been reported in similar investigations (e.g., Reichow & Wolery, 2011). For the remaining participants, Zoe and Samantha, more explicit teaching was required for only one set before secondary targets were acquired using IF.

The participant that had the greatest difficulty acquiring the secondary targets (Zoe) engaged in the fewest number of skills according to the VB-MAPP and presented with a higher score on the self-stimulation subsection of the Barriers Assessment in the form of vocal stereotypy and hyperactive behavior (Sundberg, 2008). Wolery, Werts, and Holcombe (1993) proposed that one mechanism underlying acquisition of non-targeted information via IF may be associated with the participant’s reinforcement history related to learning information incidentally or observationally. Given Zoe’s high level of vocal stereotypy, the differences in performance could be attributed to the presence of competing responses that interfere with contacting reinforcement outside of highly structured teaching sessions.

Three alternative explanations to Wolery et al. (1993) may better account for the present results and for the effectiveness of IF in general. First, participants may have engaged in covert verbal rehearsal of the IF statements, which may have resulted in skill acquisition. Future studies should consider evaluating the precision of a participant’s echoic repertoire, as this skill set may be fundamental to their success with verbal IF. Although no overt echoics were observed during the instructional sessions, the possibility of covert verbal rehearsal cannot be eliminated. It has been suggested that when an individual is *listening* to another’s speech, they are simultaneously behaving vocally (Schlinger, 2008). The individual may covertly echo the speech they are hearing, making repeating that speech in the future more likely. This type of covert vocal rehearsal has been implicated as a variable contributing to success during a number of problem-solving tasks (e.g., Esch, Esch, McCart, & Pettursdottir, 2010; Gutierrez, 2006) and may be one mechanism underlying the positive results in the current study.

If participants covertly imitated the speech of the therapist during IF trials, this covert imitation may allow them to provide correct explanations during probe trials. Of note, Zoe failed to meet mastery criteria for several sessions in sets 2 and 3 due to failure to articulate particular words. She provided an approximation of the words provided in the IF statements (e.g., saying “barbies” instead of “batteries,” saying “jacksons” instead of “jacket,”); however, given the degree of distortion of the vocalizations, they could not be scored as correct. As the IF statements were provided during additional sessions, articulation improved, though no additional vocal practice or direct shaping of her articulation was provided. If Zoe engaged in ongoing covert rehearsal, this may account for the improvement in her vocalizations on probe trials (Skinner, 1957). These mechanisms are hypothetical, however, and future researchers may wish to investigate this hypothesis by exploring the overt skills that may be necessary to engage in covert verbal rehearsal. Further inquiry in this area may focus on evaluating participant performance on multi-word vocal imitation in tasks that require both immediate and delayed performance.

Second, the results observed could be attributed to a strong generalized imitative repertoire for at least one participant (Nottingham et al., 2015). Although all participants engaged in generalized imitation, only one participant (Toby) acquired secondary targets after the introduction of IF alone. For the remaining two participants, explicit instruction of the secondary targets was required for one set before acquisition was observed in the remaining two sets. This difference across participants may indicate that a minimum level of generalized imitation may be required before IF procedures are successful. It should be noted that in the current study, data were not formally collected on vocal imitation of secondary targets. Anecdotally, none of the participants engaged in overt imitation of secondary targets. In contrast, Vladescu and Kodak (2013) and Reichow and Wolery (2011) reported consistent vocal imitation during the delivery of secondary targets. Despite the absence of data on vocal imitation, it is one possible mechanism that should be accounted for in future research.

At least one participant may have engaged in generalized tacts (e.g., tacting novel forms of stimuli without direct teaching). The results from the tact subdomain score on the VB-MAPP for Toby was higher than for the remaining two participants. In the current study, the response to the secondary target probes during teaching was a tact, which may have facilitated acquisition of the secondary target, an intraverbal, in the absence of direct teaching (Miguel, Pettursdottir, & Carr, 2005). For the remaining participants, direct teaching was required, which closely resembled intraverbal training. These data may additionally reflect a minimum tact repertoire necessary for some types of secondary targets. Specifically, as tact repertoires become more established, participants may learn more readily via IF. The tact subdomain score on the VB-MAPP was lowest for Zoe, who required the most intensive teaching. In contrast, Samantha’s tact subdomain score was higher than Zoe’s and she required a more intensive teaching procedure to acquire secondary targets, but the procedures implemented were less intensive when compared to those implemented with Zoe. Future studies may benefit from a more in-depth characterization of participants to isolate the existing verbal repertoires that are necessary and sufficient to acquire secondary targets using IF procedures.

Finally, acquisition of secondary targets may be related in part to the instructional context (Nottingham et al., 2015; Vladescu & Kodak, 2013). Secondary targets were

presented in a similar context to primary target skills, which all participants had previous experiences attending to instruction and responding to instructional cues. Participant behavioral history in the instructional context may have resulted in indiscriminable contingencies that facilitated secondary target acquisition. In the current investigation, Toby's history of reinforcement in the instructional context may have been stronger, which resulted in more generalized responding to secondary target information. In contrast, the history of reinforcement for Samantha and Zoe may have been weaker, resulting in diminished responding in the absence of direct teaching. Once explicit instruction was implemented, a stronger history of responding was present resulting in the occurrence of responding to secondary targets in the remaining stimulus sets.

The current investigation extends the literature on IF as a whole and as it relates to participants with ASD in a number of meaningful ways. First, the majority of previous investigations have measured brief responses (Falkenstine, Collins, Schuster, & Kleinert, 2009; Nottingham et al., 2015). Although appropriate for some participants, a single utterance may not assess whether or not the participant may engage in a more complex response. In the current study, the inclusion of an open-ended S^D (i.e., question) allowed for the assessment of multi-word responses and resulted in the acquisition of a longer vocal skill. The inclusion of a longer response and subsequent teaching when the response does not readily emerge after IF is delivered also provides one possible teaching method that may be helpful. Previous investigations have reported failures for IF to lead to acquisition but have not reported methods that may increase the likelihood that IF responding may emerge (e.g., Delmolino et al., 2013; Falkenstine et al., 2009).

Second, the current study presents data on maintenance of secondary targets, which is limited in the current literature base (Nottingham et al., 2015). Reichow and Wolery (2011) reported varying levels of maintenance that were lower when compared to previous IF studies. In the current data, maintenance levels across participants were also variable, with the most consistent measures demonstrated by Toby and Zoe. These two participants required the least and most intensive teaching strategies, respectively. This is perhaps not a surprising result, as the participant that required the least intensive teaching strategies perhaps had fewer overall barriers to learning. Contrastingly, the participant that required the most intensive teaching strategies received what could be considered overtraining (Hagman & Rose, 1983). Overtraining may have been a direct result of her modified mastery criterion, requiring her to meet the criterion for a longer period than the other participants. Teaching intensity may be an important factor to isolate in future research studies. Although gains were maintained across participants once teaching concluded, the variability in levels of maintenance suggest a need for further research to determine the most effective teaching procedures to facilitate durable gains over time.

Although the current investigation yielded promising results, several limitations may provide avenues for future research. First, baseline levels of responding to the primary learning target for all participants were elevated prior to introducing IF, and secondary targets were probed concurrently with primary targets. Although elevated responding in baseline for the primary target alone did not meet the mastery criteria, it may impact how readily future participants acquire IF responses. The presence of IF when probing a mastered skill may shift the participant's responding to the novel stimuli based on the

unfamiliar item and not the effectiveness of the strategy (Wolery et al., 1993). In the current investigation, praise was provided following correct responses to the primary target during baseline, we hypothesized that the participants may have engaged in the selection response to the stimuli based on their learning history of engaging in a listener response in the presence of an array of stimuli and contacted reinforcement for previously unmastered skills. Future research may benefit from expanding stimulus arrays to control for the possibility of adventitious reinforcement, or altering the reinforcement schedule such that only attending or other responses unrelated to teaching stimuli are reinforced.

In baseline, primary and secondary targets were measured concurrently, and probes were conducted regardless of responding to the primary target. This procedure did not allow for a clear determination of the participants engaged in problem explanation when presented with the correct corresponding problem picture as some problem explanation probes were conducted when an incorrect problem selection occurred. Although somewhat of a limitation, it would not be expected for a participant to engage in vocal problem solving in a natural context without first discriminating among differing stimulus forms as the initial link in a chain of behavior termed “problem solving” (Parsons, 1976). Future research may benefit from probing problem selection and explanation separately to determine what portion of the problem solving behavior chain may require teaching.

Second, the delivery of the IF in all learning trials may have hindered skill acquisition for secondary targets for Zoe and Samantha. The participants may have engaged in stimulus overselectivity, which is responding to stimuli based on restricted, incomplete, or irrelevant stimulus features (Cipani, 2012). Essentially, Zoe and Samantha may have responded to the most salient features (i.e., stimulus cards) to the exclusion of IF. Anecdotally, the therapists implementing the procedures noted considerable changes to Zoe and Samantha’s attending behaviors (i.e., gazing at the therapist) when IF was provided in the second and third sets. The explanation training may have enhanced their overall attentiveness to the therapist, allowing them to acquire the secondary target in the absence of explicit training for the future sets. Future studies should incorporate measures of attending behavior throughout the procedures, as these behaviors may play a substantial role in the acquisition of secondary targets. Additionally, diagnostic information may be beneficial in determining for whom IF procedures are the most beneficial and those participants for which more targeted teaching is needed before IF is effective.

Third, in the current study, IF was presented across all trials, which is similar to previous investigations (e.g., Falkenstine et al., 2009; Loughrey et al., 2014; Vladescu & Kodak, 2013). Although the current study provides further support for presenting IF during all trials, it does not allow for a comparison between presentation types. Previous investigations have demonstrated minimal differences between antecedent information (i.e., secondary targets delivered prior to direct instructional trials) and IF, demonstrating the possibility that a difference in secondary target location may not impact skill acquisition (Vladescu & Kodak, 2013; Wolery, Schuster & Collins, 2000). In the current study as in previous investigations, presenting IF in both error correction trials and in independent trials may have resulted in more exposure to secondary targets. Future research may benefit from directly comparing IF delivered in only correct trials and IF

delivered in both error correction and correct trials to determine if one method results in more efficient skill acquisition.

Finally, generalization data were not collected, and only one vocal explanation was taught. The purpose of the current investigation was to evaluate the acquisition of a vocal explanation of a problem situation, which can be conceptualized as an intermediate step in an overall chain of behavior that can be classified as problem solving (Parsons, 1976; Skinner, 1984). Although all participants acquired problem explanations, the extent to which these explanations were applied in the natural context was not measured. Further training may be necessary to facilitate application of these types of explanations in the natural context. Future investigations may focus on measuring physical problem solving in the natural context as well as problem solving related to novel problem situations with and without similar topographical features.

In a natural context, a problem solution may not be readily available to the individual because of a skill deficit or restriction of the necessary stimuli. For example, a child may not be able to acquire batteries for a toy because they are kept on a high shelf. In these instances, functionally equivalent methods of problem solving are necessary (e.g., asking for assistance). For example, Dotto-Fojut et al. (2011) taught four adolescent males with ASD to request assistance when presented with a problem situation (e.g., running out of materials) during vocational tasks. In the current study, participants were only taught a simple discrimination and not a conditional discrimination, which may hinder the probability of generalization for the participants in the current investigation. Extensions of the current methodology would benefit from teaching both the problem explanation as well as a vocal method of problem solving when the appropriate stimulus conditions are present in contrived and natural contexts.

Overall, IF has been demonstrated to be an effective teaching procedure that results in learning without explicit instruction (Werts et al., 1995). An emerging research base has demonstrated that this procedure may be effective for participants with ASD (e.g., Reichow & Wolery, 2011). Although promising, further investigation is needed to determine the parameters of IF that are most effective for participants with ASD, as well as its utility under typical classroom arrangements.

Compliance with Ethical Standards

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

Ethics Statement 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 was obtained for all individuals in the study.

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