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Research Article

Evaluation of an Explicit Instructional Approach to Teach Grammatical Forms to Children With Low-Symptom Severity Autism Spectrum Disorder

Katherine J. Bangert,[a] Danneka M. Halverson,[a] and Lizbeth H. Finestack[a]

Purpose: Weaknesses in the use of grammatical forms may reduce the functional use of language for verbally expressive children with autism spectrum disorder (ASD) and exacerbate difficulties with academic and social skill development. This early efficacy study evaluated a combined explicit–implicit instructional approach to teach novel grammatical forms to children with ASD.
Method: Seventeen children with ASD between the ages of 4 and 10 years who demonstrated weaknesses in expressive grammatical language completed 2 tasks, each targeting a different novel grammatical form. One form was a gender marking, which required the child to modify the verb if the sentence subject was a boy. The other form was a person marking, which required the child to modify the verb if the sentence subject was the 1st person, "I." Each form was targeted using implicit-only instruction or combined explicit–implicit instruction. With implicit-only instruction, the examiner presented models and recasts of the targeted form. With explicit–implicit instruction, the examiner presented the rule guiding the form as well as models and recasts. Learning was assessed during each of 4 treatment sessions and after a 1-week delay in 2 contexts.
Results: For the gender target form, significantly more children reliably produced the target form with explicit–implicit instruction ($\chi^2 = 4.10$, $p = .04$). For the person target form, the difference in instruction was not statistically significant. Task performance revealed a positive association with receptive language skills, but not age, nonverbal intelligence, or severity of autism-related behaviors for the person form.
Conclusion: This study provides preliminary evidence that expressively verbal children with low-symptom severity ASD can successfully learn novel grammatical forms with intervention that comprises both explicit and implicit instruction.

Autism spectrum disorder (ASD) is diagnosed based on delayed or impaired development of social communication and restricted or repetitive behaviors and/or interests that result in functional impairment (American Psychiatric Association [APA], 2013). With the release of the newest *Diagnostic Statistical Manual of Mental Disorders, Fifth Edition* (APA, 2013), significant delay in the acquisition of language is no longer a core diagnostic criterion; however, it remains a common feature associated with ASD (Eigsti, Bennetto, & Dadlani, 2007). In fact, delayed or abnormal language development is the primary reason for diagnostic referral and is a critical prognostic indicator for developmental trajectory (Howlin, Goode, Hutton, & Rutter, 2004; Kjelgaard & Tager-Flusberg, 2001; Lord & Pickles, 1996; Rice, Warren, & Betz, 2005; Wittke, Mastergeorge, Ozonoff, Rogers, & Naigles, 2017).

Although the language delays of children with ASD are heterogeneous, there is a subset of children with ASD who exhibit delays or impairments in grammatical language similar to children with specific language impairment (SLI; Rice et al., 2005; Roberts, Rice, & Tager-Flusberg, 2004). However, only a few studies have evaluated interventions specifically targeting these expressive impairments in children with ASD. Common interventions for children with SLI targeting grammar rely on implicit approaches, including recasting and modeling, with the intent of making the target form more salient in the child's linguistic environment with little or no corrective feedback regarding the child's performance (Cole, Maddox, & Lim, 2006; Ellis

[a]Department of Speech-Language-Hearing Sciences, University of Minnesota, Minneapolis

Correspondence to Katherine J. Bangert: bange017@umn.edu

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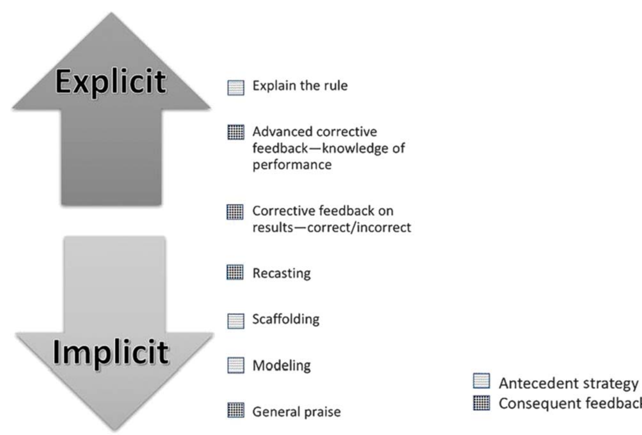
Weismer & Robertson, 2006; Leonard, Camarata, Brown, & Camarata, 2004). Unlike implicit instructional approaches, explicit approaches include the presentation of the rule or pattern that guides the use of the target grammatical form. Emerging literature suggests that interventions that combine implicit and explicit approaches are beneficial to helping children with SLI acquire grammatical forms (Ebbels, 2007; Ebbels, van der Lely, & Dockrell, 2007; Finestack, 2018; Finestack & Fey, 2009).

It is important to note that intervention approaches can fall on a continuum, with implicit and explicit approaches anchoring each end. An approach in which the interventionist's aim is to increase saliency of the target forms in a child's environment with models, recasts, and scaffolding would fall toward the implicit end of the continuum. An approach that adds direct instruction of the rules guiding target forms would be at the explicit end. Approaches may vary in their level of implicitness or explicitness. For example, the most basic form of corrective feedback provides the child with knowledge of their results, making the child aware of whether their response was correct or incorrect (e.g., "Yes, that is right!" or "Oops that isn't right"). Such an approach would fall closer to the implicit end of the continuum than a corrective approach in which the instructor or clinician provides the child with specific instruction as to why the child's response was correct or incorrect (e.g., "No, that isn't right because you forgot…"; Edeal & Gildersleeve-Neumann, 2011). Importantly, neither implicit nor explicit instructional approaches rely on the structure of the therapy session. Both can occur in therapy sessions that are either child centered with low structure in which the clinician embeds targets into the child's natural productions during child-led activities or that are clinician directed with a high level of structure in which targets are not dependent on the child's spontaneous productions and activities are clinician-led.

Instructional approaches may be further defined based on whether the clinician applies the approach before or after the child's attempt to use the target form. For example, the use of modeling to teach a target form is an antecedent implicit approach, whereas recasting the child's attempt to produce the target is a consequential implicit approach. Likewise, stating the rule guiding the target form before the child's attempt to produce the form is an antecedent explicit approach, whereas stating the rule after the child's attempt (e.g., "That wasn't quite right. You have to add *–ing* to the action word.") is a consequent explicit approach. Figure 1 represents the hierarchical nature of antecedent and consequent approaches on the explicit–implicit continuum. The purpose of this study was to evaluate a combined explicit–implicit approach that included the implicit approaches of modeling (antecedent), recasting (consequent), and corrective feedback (consequent) and the explicit approach of stating the rule guiding the target form that was presented intermittently throughout teaching episode when teaching novel grammatical forms to children with ASD.

Figure 1. Explicit–implicit continuum.



Language Profiles of Children With ASD

Despite impairment in language being a common feature of ASD, the language skills of children with ASD vary widely, and the language domains impacted differ across individuals. Some children with ASD acquire proficient knowledge and use of vocabulary, grammatical markers, and syntax with no weaknesses in articulation of speech sounds. Other children remain nonverbal or significantly impaired in all domains of language. The language development trajectory of children with ASD may be typical, follow delayed but similar milestone achievement as children with typical development, or may manifest as deviant language, such as echolalia and confused use of pronouns. (Condouris, Meyer, & Tager-Flusberg, 2003; Rice et al., 2005; Tager-Flusberg, Paul, & Lord, 2005)

In addition to documented deficits in language development relative to typically developing (TD) peers, a subgroup of expressively verbal children with ASD exhibits language weaknesses similar to those of children with SLI (Kjelgaard & Tager-Flusberg, 2001; Rice et al., 2005; Wittke et al., 2017). A core feature of SLI is poor use of grammatical forms, including high rates of omission of finite grammatical morphemes in obligatory contexts (e.g., past tense *–ed,* third-person singular *–s*; Rice & Wexler, 1996). Moreover, children with SLI typically demonstrate relative strengths in vocabulary compared to grammatical ability (Eisenberg & Guo, 2013; Rice & Wexler, 1996; Roberts et al., 2004). Kjelgaard and Tager-Flusberg (2001) found similar characteristics in a group of children diagnosed with ASD. They investigated the receptive and expressive language skills of 82 children diagnosed with ASD between the ages of 4 and 14 years. More than 50% of children in the sample were categorized as language impaired based on scores on the Peabody Picture Vocabulary Test–III (Dunn & Dunn, 1997). Among these children, a consistent profile emerged such that vocabulary skills were higher than grammar. Within a subgroup of children with ASD and low language skills, vocabulary was less impaired than higher order morphosyntax skills (i.e., grammar). A more detailed follow-up investigation of this cohort (Roberts et al., 2004) revealed a subgroup of children who exhibited specific delays in the use of grammatical forms similar to those found in children with SLI. This subgroup was characterized by significantly lower scores on both third-person singular and past-tense probes when compared to children in the normal language group and language borderline group.

Grammar weaknesses are also evident when children with ASD are compared to children with other developmental disabilities, such as intellectual disability or developmental delay (DD; Eigsti et al., 2007; Rice et al., 2005). For example, Eigsti et al. (2007) found significantly poorer use of grammatical forms by children with ASD, aged 3–6 years, compared to children with DD and those with typical development matched on nonverbal IQ. Index of productive syntax (Scarborough, 1990) scores for the group of children with ASD was significantly lower than both DD and TD groups. Eigsti et al. suggested that children with ASD may use more grammatically simple language than other children because of conceptual limitations and weaknesses in the use of language for social purposes to converse about more abstract or nonpresent topics. Thus, evidence suggests that a large proportion of children with ASD also demonstrates language impairment, and a subgroup of children with ASD have impaired language profiles similar to children with SLI. It is therefore likely that practicing speech-language clinicians will come across children with ASD who demonstrate a need for intervention focused on improving grammatical language skills.

Grammatical Interventions for Children With ASD

The current literature base of interventions specifically targeting the grammar skills of children with ASD is small, despite evidence revealing significant deficits in these areas among this group. We identified two studies in which researchers, using single-case research designs, found significant positive intervention gains when targeting the grammatical abilities of children with ASD (Fischer, Howard, Sparkman, & Moore, 2010; Hendler, Weisberg, & O'Dell, 1988). These studies targeted a variety of structural forms ranging from pronoun use to more complex sentence structures. In both studies, reinforcement and corrective feedback on performance were key strategies in the interventions and therefore involved some degree of explicitness (e.g., the child was instructed on whether their productions were correct); however, the rule guiding the grammatical targets was never presented. Despite noted gains in grammar targets, in both studies, the time to reach mastery for the children required numerous sessions (32 or more), spanning across many weeks.

Explicit Instruction for Children With SLI

A recent body of literature has emerged in which a combined explicit–implicit approach has been found to be efficacious and in some cases more efficacious than implicit-only approaches to teach grammatical forms to children with SLI. Ebbels (2007) employed a combination of explicit and implicit approaches, which used shapes to explain grammatical constructs to children. As part of the study, interventionists taught nine children, aged 11–13 years, a visual coding system of arrows to help them identify and organize tensed and nontensed verbs in sentences. The interventionists provided explicit instruction, such as "main clauses must have one (and only one) down arrow [tensed verb]." Interventionists also gave the children feedback on their production accuracy and advanced feedback on why their sentences were correct or incorrect. Of the nine students, six improved their accuracy of past tense forms on pre– versus post–past tense use in spontaneous written work, with the mean percentage of growth in past tense verb use increasing by an average of 7%. However, there was one student who decreased in performance significantly, which affected the group's mean difference in performance (Ebbels, 2007).

Ebbels et al. (2007) completed a randomized control trial examining use of the same visual coding intervention method with children aged 11–16 years with SLI. In this study, three intervention approaches were compared: a syntactic–semantic approach, semantic approach, and control intervention. The syntactic–semantic approach mirrored the Ebbels (2007) visual coding system described above. The semantic approach included explicit instruction on the meaning of verbs in their gerund form. The control therapy involved using context cues to work out the meaning of sentences. Both the syntactic–semantic and semantic approaches involved more explicit instruction than the control treatment. After just nine therapy sessions, totaling 4.5 hr of treatment, children in the syntactic–semantic and semantic intervention groups demonstrated statistically significantly higher gain scores on the targeted gerund forms than the control group.

Bolderson, Dosanjh, Milligan, Pring, and Chiat (2011) investigated the use of another explicit intervention similar to the visual coding system called, *Colorful Semantics,* in which color coding highlighted the predicates of sentences being taught. All children improved their grammar scores in pre- to posttest informal assessments, but not during baseline.

In contrast to these studies, Swisher, Restrepo, Plante, and Lowell (1995) did not find an advantage for an explicit teaching approach relative to an implicit approach when teaching two novel nouns and one novel morpheme to children, aged 6–9 years, with SLI (n = 25) and TD (n = 25). The TD children showed significant differences between the two teaching conditions, with more correct generalizations on the posttest. Children with SLI in the explicit group, however, did not demonstrate an advantage over children in the implicit group. Overall, the implicit and explicit tasks both appeared to be too difficult, particularly for the children with SLI.

Finestack and Fey (2009) also directly compared the efficacy of combined explicit–implicit instruction to an implicit-only approach to teach novel grammatical inflections to children with primary language impairment (PLI). Participants included 34 children, aged 6–8 years, who were randomly assigned to an explicit teaching condition or an implicit-only teaching condition. In both conditions, the teaching target was a novel grammatical morpheme that marked the gender of the subject on the verb of the sentence. Teaching occurred across four sessions in a 2-week period. Participants in the explicit–implicit teaching condition received intermittent direct instruction regarding the grammatical pattern ("If it is a boy, you have to add *–pa* to the end. If it is a girl, you have to add *–po* to the end."). Participants in the implicit-only teaching condition received nonspecific instruction ("Listen closely so you can talk just like *Tiki.*"). To assess learning, while viewing stylized pictures of characters engaging in common actions (e.g., dance, run, drink), participants in both groups completed sentences using the space creature's language, such as "*Mike can* _____." For both groups, corrective feedback on their performance with recasts was given ("Oops! That isn't how Tiki talks. Listen to Tiki again, *'Mike can laugh-pa'*").

Significantly more children who received explicit–implicit instruction met criteria to be considered "pattern-users" (PUs; produced target form with at least 80% accuracy; $n = 12$) than those who received implicit-only instruction ($n = 5$). Children who received explicit–implicit instruction also generalized the novel inflection to untrained items. Analyses of participant characteristics suggested there were no associations between language performance, nonverbal intelligence, and task performance. These findings suggest an advantage for a combined explicit–implicit intervention procedure over an implicit-only intervention procedure for teaching children with PLI to use a novel grammatical morpheme accurately in a highly controlled environment over a relatively small number of treatment sessions.

Explicit Instruction for Children With ASD

An explicit approach to teach grammatical forms may be particularly beneficial for children with ASD. Klinger, Klinger, and Pohlig (2007) proposed that deficits in implicit learning for individuals with ASD lead them to use more effortful, explicit approaches to accomplish tasks that appear effortless for TD children, such as learning the grammar and semantic relationships that underlie language. Klinger and Dawson (2001) investigated the relationships between performance on explicit and implicit learning tasks in 50 children with ASD, aged 5–17 years. Children with ASD performed significantly below a comparison group of TD peers on probes assessing implicit learning; however, the groups performed similarly in the explicit condition. For the implicit learning task, examiners asked the children to categorize pictures of animals without any instruction on the categories; whereas, in the explicit condition, examiners provided the children the rule that governed each category (i.e., animals with long necks). Follow-up investigations by Klinger et al. (2007) found implicit learning performance to be strongly related to both social and communication symptoms in children with ASD, such that poorer performance on implicit learning was correlated with more severe symptoms. This suggests a positive relationship between weaknesses in implicit learning and language development in ASD.

In sum, evidence suggests that impairments in grammar similar to children with SLI are evident for a subgroup of children with ASD (Condouris et al., 2003; Eigsti et al., 2007; Roberts et al., 2004). There have been few studies aimed at ameliorating these structural deficits in children with ASD (i.e., Fischer et al., 2010), all of which have delivered instruction over a long time with many treatment sessions. Previous investigations (Bolderson et al., 2011; Ebbels et al., 2007; Finestack, 2018; Finestack & Fey, 2009) revealed an advantage for a combined explicit–implicit approach when teaching children with PLI to acquire grammatical forms over a shorter time with relatively few treatment sessions. However, no direct comparisons have been made between explicit–implicit approaches and implicit approaches for teaching grammatical forms to children with ASD. Further, existing studies of grammatical interventions for children with ASD have relied on single-case research designs.

Current Study

We conducted an early efficacy study (Fey & Finestack, 2009) to determine if more expressively verbal children with ASD with grammatical deficits produce a novel grammatical inflection when taught using a combined explicit–implicit approach than when taught with an implicit-only instruction approach. The children in our study were required to be verbally fluent with a nonverbal IQ over 80, which, consequently, likely narrows the scope of ASD severity symptoms. This study therefore reflects an intervention approach aimed toward a group of children with lower symptom severity of ASD in the moderate to mild range, who still experience weaknesses in the production of grammatical forms. We examined the efficacy of each approach when targeting novel grammatical morphemes using a computer-based intervention paradigm. Both the explicit–implicit and implicit-only approaches included computer models and recasts of the target language form and corrective feedback to the learner during teaching opportunities. Explicit–implicit instruction also included intermittent presentations of the rules guiding the target novel grammatical morphemes. The primary research question was:

- Do children with ASD learn to contingently apply a novel grammatical form with greater accuracy if taught using a combined explicit–implicit rather than implicit-only intervention approach?

Our secondary research questions were:

1. Do more children with ASD who receive explicit–implicit instruction and learn to apply a novel grammatical form maintain accurate use after a 1-week delay and generalize the novel grammatical form to a play context than children who receive implicit-only instruction?
2. Do the language, cognitive, or behavioral profiles of children with ASD who learn to apply the novel grammatical form with explicit–implicit instruction differ significantly from those who do not learn to use the marking?

Based on findings from Finestack and Fey (2009) and Klinger et al. (2007), we predicted that more children with ASD would learn to contingently apply a novel grammatical form with explicit–implicit instruction than implicit-only instruction. We further predicted that more children with ASD who learned to produce the novel grammatical form would maintain the form after a 1-week delay and generalize the form if it was taught with explicit–implicit instruction than if taught with implicit-only instruction.

Finally, we predicted that children with ASD who learned to contingently apply the novel grammatical form would present with different language profiles than children who did not learn the marking. Finestack and Fey (2009) found no associations between language performance, nonverbal intelligence, and task performance in their sample of children with PLI. However, children with ASD and language impairment have been found to have lower performance on language tasks than children with SLI (Roberts et al., 2004). Thus, we hypothesized that children who did not learn the novel grammatical markings would present with weaker language profiles than children who did learn the novel markings.

Method

Participants

A total of 17 children with ASD between the ages of 4 and 9 years participated in the study. This age range reflects the ages of children speech-language pathologists will most likely encounter when providing grammatical intervention to this population. To be eligible to participate, children needed to be previously diagnosed with an ASD (including Asperger's syndrome or pervasive developmental disorder—not otherwise specified for those whose diagnosis predated the release of the *Diagnostic Statistical Manual of Mental Disorders, Fifth Edition*; APA, 2013) and live in a monolingual English-speaking household. Parents provided documentation of their child's diagnostic evaluation, and only children with a documented medical diagnosis or educational qualification status of ASD were eligible to participate.

Participants also had to meet inclusionary criteria based on assessments administered by the researchers. Primary inclusionary assessments included the Structured Photographic Expressive Language Test–Third Edition (SPELT-3; Dawson, Stout, & Eyer, 2003) and the brief form of the Leiter International Performance Scale–Revised (Leiter-R; Roid & Miller, 1997). The SPELT-3 includes 54 full-color photographs of everyday situations and objects paired with verbal questions and statements to elicit specific morphological and syntactic structures. Children who obtained a standard score on the SPELT-3 below 95 to confirm structural language impairment were included in the study. A cutoff of 95 on the SPELT-3 was chosen because it has previously been shown to have high sensitivity (90%) and specificity (100%) for identifying young children with expressive language impairments (Spaulding, Plante, & Farinella, 2006).

The Leiter-R is a nonverbal IQ test administered completely nonverbally through examiner use of pantomimes, gestures, and facial expressions. The brief form assesses visualization and reasoning skills, including pattern repetition and figure-ground identification. To rule out cognitive delay, only children with a standard score above 70 were included in the study.

Children were also excluded from the study if they failed a hearing screening (detect 25 dB pure tones at 1000, 2000, and 4000 Hz in at least one ear) or failed a phonological probe requiring the child to produce the target phonemes /ʃ/ and /f/ used in this study's experimental tasks.

Seventeen participants (two female, 15 male) completed all activities and met eligibility criteria, including 13 with diagnoses of ASD, one with a diagnosis of Asperger's syndrome, and three with diagnoses of pervasive developmental disorder—not otherwise specified. All participant families self-reported as non-Hispanic White. Of the sample, one participant family reported that their annual household income was less than $25,000, one reported income of $25,001–$50,000, seven reported income of $50,001–$100,000, two reported income of $100,001–$150,000, and five reported income greater than $150,001. Six of the mothers indicated that they had graduate degrees, four reported bachelor of science/arts degrees, three reported an associates or technical degree, and one reported that their highest level of education was high school graduate. Three mothers did not provide information regarding their education. Researchers administered all assessment measures across experimental sessions such that no session exceeded 1 hr. Table 1 includes participant group descriptive characteristics.

Additional Participant Measures

Participants completed the Test for Auditory Comprehension of Language–Third Edition (TACL-3; Carrow-Woolfolk, 1985), a standardized, norm-referenced test for

Table 1. Participant group characteristics (*n* = 17).

Characteristic	*M*	*SD*	Min–max
Age (years)	6.4	1.62	4.3–9.7
Nonverbal intelligence[a]	98.88	19.01	71–135
Expressive language[b]	73.35	15.48	47–93
Receptive language[c]	86.41	21.32	55–128
Autism symptoms[d]			
CARS2-HF (*n* = 13)	27.50	4.27	24–36.5
CARS2-ST (*n* = 4)	39	8.73	31–51

[a]Standard score with *M* = 100, *SD* = 15 based on the Leiter International Performance Scale–Revised.
[b]Scaled score with *M* = 100, *SD* = 15 based on the Structured Photographic Expressive Language Test–Third Edition.
[c]Scaled score with *M* = 100, *SD* = 15 based on the Test for Auditory Comprehension of Language–Third Edition.
[d]Raw score on Childhood Autism Rating Scale 2–High Functioning version (CARS2-HF) where a cutoff of 28 or higher indicates mild–moderate symptoms of autism spectrum disorder or Childhood Autism Rating Scale 2–Standard version (CARS2-ST) where a cutoff of 37 or higher indicates severe symptoms of autism spectrum disorder.

children ages 3 through 9 years, to assess comprehension of aurally presented English vocabulary, grammatical forms, and elaborated phrases. Performance on this assessment was not part of our inclusion criteria, but was used to further characterize participants and analyze as a moderator.

Clinicians completed the Childhood Autism Rating Scale–Second Edition (CARS-2; Schopler, Van Bourgondien, Wellman, & Love, 2010) to further describe participants' ASD symptomology. The Childhood Autism Rating Scale 2–Standard version (CARS2-ST) rating scale is for children between the ages of 2 and 6 years, or children age 2 years or older with significantly impaired communication and/or cognitive abilities. The Childhood Autism Rating Scale 2–High Functioning version (CARS2-HF) rating scale is for children 6 years or older who are verbally fluent and have an IQ above 80. Items require judgments of behaviors central to ASD, including nonverbal communication, relationships, repetitive behaviors, rituals and routines, and presence of hyper/hypo sensitivity. In the current sample, four children received ratings on the CARS2-ST, and 13 children received ratings on the CARS2-HF. Due to improper administration of the CARS2-ST, one participant's data for the CARS2-ST were not included in our analyses. Raw scores on each scale are interpreted relative to a clinical sample of individuals diagnosed with ASD to categorize a child's degree of autism-related behaviors as minimal, moderate, or severe. Three children in the current sample who received ratings on the CARS2-HF scored in the minimal to no symptoms severity category. Because all participants provided confirmation of diagnosis to participate in the study, and so we could analyze results by severity, we kept the children who scored in the minimal-to-no symptoms in our analyses. All other children who received ratings on the CARS2-HF or CARS2-ST scored in the mild–moderate symptoms or severe symptoms categories.

Experimental Task: Novel Grammatical Markings

Researchers, who were trained graduate or undergraduate speech-language pathology students, taught a novel grammatical target form in up to four teaching sessions that took place in participants' homes and ranged from 20 to 30 min. During each teaching session, participants played a space-themed computer game on a laptop computer. In each game, participants attempted to learn either a novel gender or person grammatical form. For the novel gender marking pattern, if the sentence subject was male, the verb carried a phonemic marking (/ʃ/ or /f/). If the sentence subject was female, the verb did not carry a marking. Each gender model sentence had the following syntactic structure: subject + *can* + infinitive form of the verb + (marking or no marking). Examples following the gender marking pattern include *Matt can read-f* (or *Matt can read-ʃ*) and *Maddy can swim*. To present this model, a computer displayed one cartoon graphic of a girl or a boy character performing an action. This marking and the model items are similar to those used by Finestack and Fey (2009). Figure 2 illustrates an exemplar cartoon used for the gender marking.

Figure 2. Sample visual stimuli for gender marking.

The written text is included in the figure for descriptive purposes; it did not appear on the participant's computer display.

For the novel person marking, the end of the verb carried a phonemic marker if the space creature (and speaker) was the agent of action. If another individual who was not the speaker was the agent of action, the end of the verb did not carry a marking. Each model sentence had the following syntactic structure: *Now* + subject (*I*/ *You*) + infinitive form of verb + (marking or no marking). Examples following the person marking pattern include *Now I drive-ʃ* (or *Now I drive-f*) and *Now you paint.* To present this model, a computer displayed one cartoon graphic of the space creature ("Wobo") and a cartoon boy, one of whom performed an action whereas the other was present. Figure 3 illustrates an example cartoon used for the person marking. The written text did not appear on the computer display. For the models of both novel forms, if the verb carried a novel marking, the last sound of the verb and the phonetic marker were each fully articulated; however, there was not a pause between the two segments.

Group Assignment

Researchers randomly assigned each participant to one of eight sequences specifying the order of presentation of the experimental tasks addressing the novel grammatical forms (gender vs. person), the type of instruction provided during the experimental task (implicit-only vs. explicit–implicit), and the phonological form used as the gender or person marking (/ʃ/ or /f/). These counterbalanced sequences were randomized in blocks such that after every eighth participant, half of the participants would have completed

Figure 3. Sample visual stimuli for person marking.

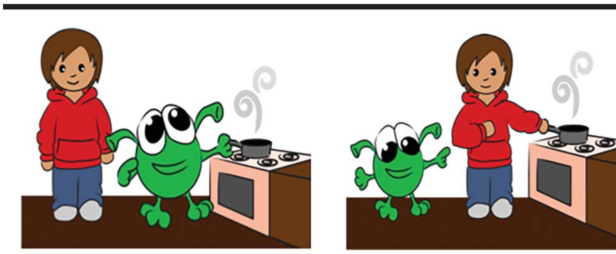
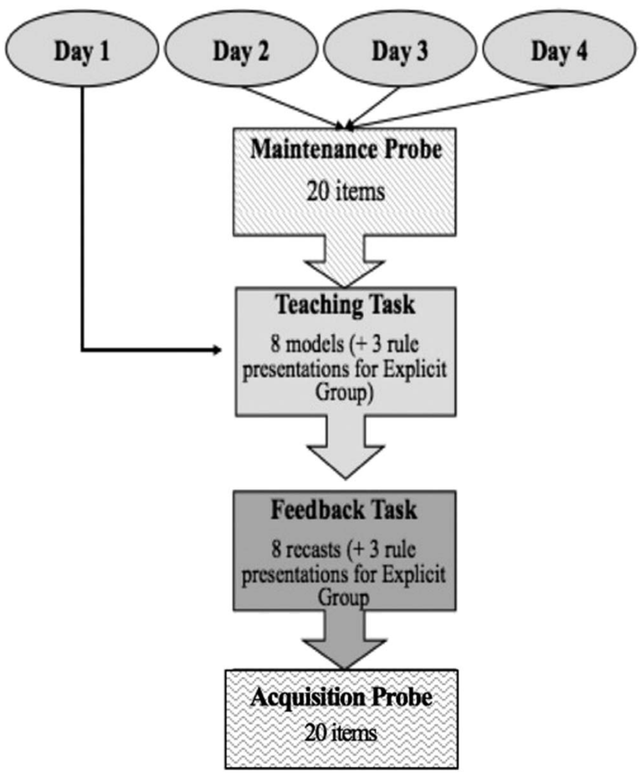


Figure 4. Structure of each experimental session.



the gender task first with either explicit–implicit or implicit-only instruction.

Experimental Sessions

All experimental sessions included a Maintenance Probe, Teaching Task, Feedback Task, and Acquisition Probe with exception of the first day, which did not include a Maintenance Probe. A 1-week follow-up session occurred after each intervention period was completed. Figure 4 illustrates the structure of each experimental teaching session for each space game.

Teaching task. At the beginning of the task, the computer instructed the participant that a creature had just arrived on Earth and that, while the creature uses many of the same words that we do, there is something different about the way the creature talks. The computer instructed participants to try to learn the creature's language so that they can talk just like the creature. Participants then viewed eight separate color graphics and listened to corresponding sentences describing the graphic using the novel grammatical form. Participants did not receive instruction to produce the targeted form during any of these trials.

Explicit–implicit teaching. Before the first, after the fourth, and after the eighth presentation of the graphic and corresponding novel form, participants assigned to the explicit–implicit condition heard a description of the pattern governing the novel grammatical marker (e.g., novel person marking: "When you or the creature talks about yourself, you have to add *–sh* to the end. When you or the creature talks about someone else, you don't add anything to the end"; novel gender marking: "When you or the creature talks about a boy, you add *–f* to the end. When you or the creature talk about a girl, you don't add anything to the end"). The teaching trials did not occur after every presentation so the task would not be too overwhelming and to give the child time to observe. A similar interval for intermittent explicit presentations of the guiding rules was used in Finestack and Fey (2009), and Finestack (2018).

Implicit-only teaching. Similar to the explicit–implicit teaching task, before the first, after the fourth, and after the eighth presentation of the graphic and corresponding novel form, the children in the implicit-only group received a prompt to attend to the space creature's language (i.e., "Listen carefully, so you can talk just like the space creature"). Importantly, the only difference between the two teaching conditions was that participants assigned to the implicit-only condition did not hear the novel rule description and instead intermittently heard a prompt to listen carefully.

Feedback task. Immediately following the modeling trials, participants had eight opportunities to produce the grammatical marking using the pattern exemplified in the models. The creature began the sentences describing the pictures, and the examiner prompted the participant to complete the sentences as the creature would. For both teaching groups, if the participant completed a given sentence correctly, they received positive feedback on performance and heard the sentence again (e.g., "That was right. Listen to the creature again, 'Mike can dance-sh'"). If the participant did not respond or produced an incorrect response, they received corrective feedback on performance and the sentence was recasted (e.g., "Oops, that isn't how the creature talks. Listen to the creature again, 'Mike can dance-sh'"). After the feedback, the computer presented the next trial. As during the Teaching Task, children in the explicit–implicit group were presented with the rule before the first, after the fourth, and after the eighth trials. Participants in the implicit-only group again received prompts to listen carefully, instead of being presented with the rule. Thus, both groups received models and recasts and corrective feedback on performance that occurred consequently; the only difference between the two conditions was the intermittent explicit presentation of the rule guiding the novel form. Children in the explicit–implicit condition intermittently heard the rule, and those in the implicit-only group only heard a prompt to listen carefully during the intermissions. Again, these intermittent presentations were similar to the intervals used in Finestack and Fey (2009), and Finestack (2018).

Acquisition probe. The Acquisition Probe occurred at the end of each session to evaluate learning. Just as in the Feedback Task, participants viewed a graphic for each item and the researcher prompted the participant to complete the sentence just as the space creature would (i.e., the creature only began the sentence: "Mike can…"). Researchers guided participants to respond as quickly and correctly as possible. The probes did not include explicit or implicit instructions regarding the creature's language, and participants did not receive feedback regarding their performance. Each Acquisition Probe included 20 randomized items: 10 identical to the subject + verb depictions used during the Teaching Task and 10 unique items depicting subject + verb depictions not used during the Teaching Task. The probe included an equal number of items requiring the novel marker (e.g., gender marked: "Nick can read-*f*") and items not requiring a novel marking (e.g., gender unmarked: "Ashley can swim").

Maintenance probe. For each targeted form, the Maintenance Probe occurred at the beginning of Sessions 2, 3, and 4. The Maintenance Probe allowed monitoring of preserved learning between sessions and served as the criterion for determining progression to the second novel grammatical marker or task completion. The format of the Maintenance Probe was the same as the Acquisition Probe, and the items included in the probe were identical to the previous session's Acquisition Probe.

Maintenance Sessions

Follow-up maintenance probe. One week following the completion of intervention for each target (gender form: M = 7.6 days; range = 7–16 days; person form: M = 12.5; range = 7–37), participants completed a Follow-up Maintenance Probe. The Follow-up Maintenance Probe included 20 computer-based items similar to those used in the Generalization and Maintenance Probes during the intervention sessions. This probe did not include explicit or implicit instructions regarding the creature's language or constructive feedback.

Generalization probe. After the Follow-up Maintenance Probe, participants played a game with the examiner in which they manipulated toys and plush space creatures similar to those depicted in the computer graphics. During these toy plays, the experimenter prompted participants to use the target forms as they did during the computer activity. The participant completed a randomized sequence of 16 items evenly distributed across those requiring the novel marker and those not requiring it. This probe also did not include explicit or implicit instructions regarding the creature's language or feedback.

Progression of Experimental Sessions

Completion of all sessions for both grammatical targets required approximately 4–5 weeks. Participants completed teaching sessions for the person target form in 8 to 41 days (M = 20 days) and for the gender target in 7 to 37 days (M = 18 days), depending on family availability and scheduling needs. The number of teaching sessions for each grammatical target depended on the performance of the participant. If a criterion of 80% or higher accurate responses was attained during the Maintenance Probe of the session, the researcher discontinued the progression of tasks for that game. At this point, the participant either moved on to the next grammatical target or ended the session. This progression criterion was used because researchers determined that if the participant demonstrated sufficient mastery of the target form during maintenance, it was unnecessary to readminister the Teaching Task. All participants progressed, either to the following game or to the final 1-week wait period before the follow-up session, after a maximum of four sessions for each grammatical target (range = 2–4 sessions for both targets).

Data Coding

The examiners recorded each session using the internal microphone of a portable audio recorder (Marantz PMD661 or Marantz PMD620). A trained coder blinded to the instruction (explicit–implicit or implicit-only), session number, and probe type (feedback, maintenance, or generalization) scored each participant's responses. The coder scored responses as correct or incorrect. A response was correct if (a) the child produced the correct response for an accurately substituted verb (e.g., *Jake can smile-ʃ* when the intended target was *laugh-ʃ*); (b) the child did not produce a verb, but produced the appropriate marking (i.e., *Jake can-ʃ*); or (c) the child added the marking to an object of the sentence (e.g., *Jake can eat pizza-ʃ*). The coder scored responses including a consistent phonetic distortion of the marking as correct. If the child produced a long pause before the target form, responses were counted as correct as long as the marking was accurate.

The coder scored all other responses as incorrect, including addition of the target phoneme to items that did not require the target phoneme (e.g., female subjects: *Ashley can eat-f* or second-person agents: *Now you look-f*), production of a bare verb that required a marking (e.g., male subject or first-person agent), or inconsistent substitution of a phoneme other than /f/ or /ʃ/. A response received a separate code if the utterance was inaudible or unintelligible.

A second coder independently rescored a random selection of 32% of all probes to determine interrater reliability. Applying the absolute agreement definition, researchers calculated a two-way random effects intraclass correlation coefficient (ICC). The ICC provides a measure of reliability between the judges, indicating the proportion of variance in the scores that is related to the participants' performance rather than that of the judges (Berk, 1979; Suen & Ary, 1989). The ICCs for the maintenance and acquisition probes were both .94, and the feedback probe was .99. This indicates that the judges contributed only a very small part of the variance in the children's scores.

Two of the verbs used for the intervention included ending sounds that matched the novel grammatical form. These include *push,* which occurred in the person-form game, and *laugh*, which occurred in the gender-form game. Random assignment placed the children in the counterbalanced sequence in which the novel form matched the ending sounds for both verbs (e.g., *laugh-f, push-ʃ*). This occurred for five of the 17 children in our sample. This required the clinicians and coders to closely attend to the children's productions of these forms when the novel phonetic marker was required. To ensure that the matching phonetic forms of the verb and the marker were not a confound, we double-checked agreement between the coder and the clinician for maintenance and generalization tasks. The children who did appropriately apply the form were able to emphasize the sound clearly so that the clinician and coders agreed on the accuracy. This matching phoneme combination appeared only once per 20 trials; thus, if it was indeed falsely marked as correct or incorrect, it did not greatly impact the child's overall performance.

Fidelity of Treatment

To determine fidelity of intervention implementation, trained coders also scored the presentation of feedback responses during the Feedback Task of each teaching session. The coders scored whether the experimenter prompted the computer to provide the correct feedback (i.e., the participant was correct and the experimenter provided reinforcing feedback, or the participant was incorrect and the experimenter provided corrective feedback) or whether the experimenter prompted the computer to provide incorrect feedback (i.e., the participant was incorrect and the experimenter provided reinforcing feedback, or the participant was correct and the experimenter provided corrective feedback).

Researchers calculated fidelity by aggregating experimenter performance for each participant across all days of feedback. Overall, average experimenter fidelity was 94.7%. When separated by instruction type, clinician fidelity to treatment was 95.8% for explicit–implicit instruction and 93.5% for implicit-only instruction. The majority of experimenter errors were instances where the child produced the correct response and the experimenter provided incorrect feedback. These were often cases where the child produced the grammatical marking after an extended delay following the verb, and the experimenter had already initiated the "incorrect feedback" response. In those cases, the examiner interrupted the computer and told the child that they hit the button too soon, gave praise, and repeated the child's production. Approximately 20% of the feedback tasks were independently coded by another research assistant to establish reliability of fidelity of treatment codes. Due to a large amount of 100% fidelity ratings across judges, the distribution of scores was highly skewed, with heavy loading at the 100% scores. Thus, an arcsine transformation was applied to the ratings. Applying the absolute agreement definition, researchers calculated ICC using a two-way random effects model with arcsine-transformed values of the percentage of correctly presented trials. This yielded an ICC of .79, which indicates that a small percentage of variation in scores was due to differences between judges.

Statistical Design

Researchers categorized participants who performed at a criterion of 80% or higher of correct responses on the 20-item Acquisition Probe during a single teaching session as a pattern user (PU) for that grammatical marker. If the participant did not attain a criterion of 80% or higher accuracy during any experimental session for that particular grammatical marking, researchers categorized the participant as a non–pattern user (Non-PU). An 80% criterion level was also the mastery criterion in the Finestack and Fey (2009), and Finestack (2018) studies to classify participants as PUs and Non-PUs. It is also a common criterion used by practitioners when assessing grammatical targets in clinical settings.

The researchers completed analyses using within-subject and between-subjects, nonparametric 2 × 2 contingency tables. The number of participants categorized as PUs served as the dependent variable. Teaching condition and grammatical marking served as independent variables for individual tables. An alpha level of .05 or lower was set to reject the null hypothesis for each research question. Researchers also calculated Phi (Φ) values, where applicable, to represent effect size. Phi values range from 0 to 1.0 and indicate the strength of the relationship between two variables, with values of 0.10, 0.30, and 0.50, respectively, representing small, medium, and large effect sizes (Green & Salkind, 2003). Finally, researchers completed multiple regression analysis with PU status as a binary outcome variable. With instruction type held constant, age, ASD symptom severity, language, and cognitive ability served as independent variables.

Results

Primary Research Question

The primary aim of this study was to determine if participants with ASD produce a novel grammatical form with greater accuracy if taught using an explicit–implicit intervention approach or an implicit-only approach. The researchers used participant performance on the 20-item Acquisition Probe to determine PU of the target grammatical form. In the first analysis, participant classification is collapsed across the two grammatical targets to examine the main effect of instruction type. Thus, each participant's classification for both instruction types is included in the analyses. Using a within-subject design, we compared each participant's performance with explicit–implicit instruction and implicit-only instruction. Table 2 includes the number of participants who became PUs with each instructional approach.

Six participants became PUs after receiving explicit–implicit instruction, while 11 participants remained Non-

Table 2. Performance on Acquisition Probe.

Instruction type	Use classification: PU		Non-PU
Forms combined			
Explicit–implicit	6		11
Implicit-only	1		16
		p = .06 Φ = 0.43	
Gender form			
Explicit–implicit	3		5
Implicit-only	0		9
		p = .04 Φ = 0.50	
Person form			
Explicit–implicit	3		6
Implicit-only	1		7
		p = .31 Φ = 0.25	

Note. PU = pattern user.

PUs. In comparison, only one participant became a PU after receiving implicit-only instruction, while 16 remained Non-PUs. Results from the nonparametric-related samples McNemar's Test revealed no significant difference between PUs and Non-PUs (χ^2 = 3.2, p = .06); however, the corresponding effect size was medium (Φ = 0.43).

In the next set of analyses, we compared performance with explicit–implicit instruction and implicit-only instruction for each target form. For the gender form, three of eight participants became PUs with explicit–implicit instruction, and zero of nine participants became PUs with implicit-only instruction. Results from the Fisher's exact test revealed this difference was statistically significant (χ^2 = 4.10, p = .04), with a corresponding large effect size (Φ = 0.50). For the person form, three of nine participants became PUs with explicit–implicit instruction, and one of eight became a PU with implicit-only instruction. This difference was not statistically significant (χ^2 = 1.02, p = .31), and the effect size was small (Φ = 0.25). Table 2 presents the number of PUs for the gender and person forms. Figure 5 displays participants' performance each day by instruction type and target form.

Secondary Research Question 1

For our first secondary research question, we examined follow-up maintenance and generalization of the novel grammatical forms among participants who became PUs during the intervention sessions. One-week post intervention, examiners assessed the participants' ability to use the target forms on a probe identical to those used during the teaching sessions and on a toy-based Generalization Probe. On the Follow-up Maintenance Probe, four of the six participants who became PUs with explicit–implicit instruction and the one PU who received implicit-only instruction continued to demonstrate their learning of the grammatical pattern on the computer probe 1 week later. The McNemar's Test revealed that this difference in PU performance was not significantly different across groups (χ^2 = .65, p = .42), with a small effect size (Φ = 0.20).

On the Generalization Probe, three of the six children in the explicit–implicit group who were PUs generalized their pattern use to the play-based manipulation of toys after the 1-week delay. The implicit-only learner who became a PU also generalized the pattern from the computer to the to the toy context. The difference between how many children remained PUs with toys in the explicit–implicit and implicit-only PUs was not significant (χ^2 = .5, p = .50). Table 3 includes PU status on the Follow-up Maintenance and Generalization Probes.

Secondary Research Question 2

To investigate the relationships between treatment outcomes, age, language ability, cognitive ability, and ASD

Figure 5. Gender and person Acquisition Probe percent correct by instruction type.

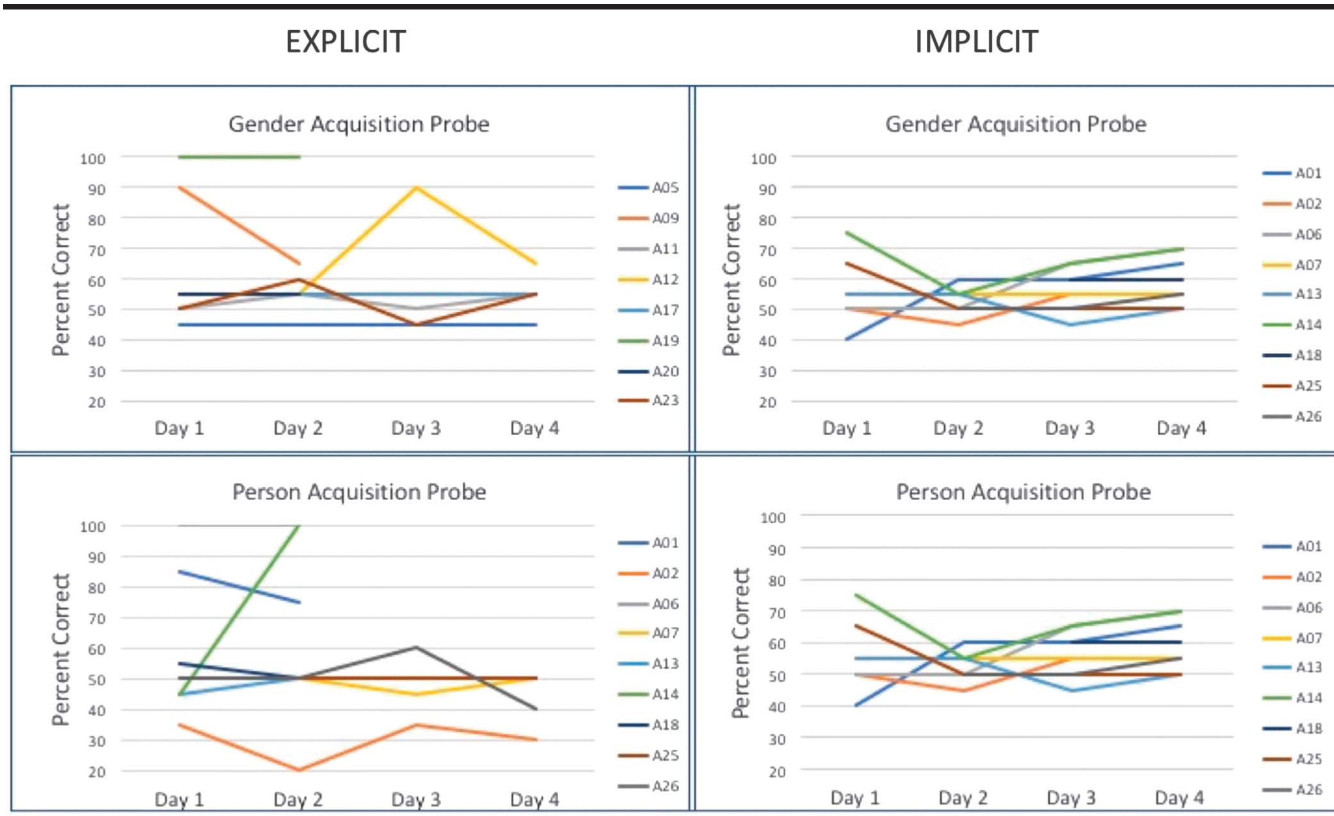


Table 3. Of pattern users (PUs) on Acquisition Probe, PU status on 1-week post–Maintenance Probe, and toy-based Generalization Probe.

	Maintenance Probe		Generalization Probe	
Instruction type	**PU**	**Non-PU**	**PU**	**Non-PU**
Forms combined				
Explicit–implicit	4	2	3	3
Implicit-only	1	0	1	0
Gender form				
Explicit–implicit	2	1	1	2
Implicit-only	0	0	0	0
Person form				
Explicit–implicit	2	1	2	1
Implicit-only	1	0	1	0

symptom severity, we completed multiple logistic regression analyses for both the gender and person forms. The dependent variable was the binary outcome measure of PU versus Non-PU, with teaching type held constant. Teaching type was coded as 0 = implicit-only and 1 = explicit–implicit, and age was coded in months. Age, SPELT-3, TACL-3, Leiter-R scaled scores, and CARS-2 ASD symptom severity percentile rank served as independent variables. Variables were entered into the equation simultaneously. For the gender form model, a significant equation was not found for teaching type alone, nor when developmental variables were added to the model, $F(1, 16) = 4.2$, $p = .06$; $F(5, 16) = .147$, $p = .82$, with an R^2 of .23 and .38, respectively. For the person form, there also was not a significant equation with instruction type alone, $F(1, 16) = 1.27$, $p = .28$, with an R^2 of .08. When the other variables were added, however, the model was significant, $F(5, 16) = 3.59$, $p = .049$, with an R^2 of .69. Age ($\beta = .40$, $p = .13$), SPELT-3 ($\beta = .42$), TACL-3 ($\beta = .49$, $p = .05$), CARS-2 ($\beta = -.24$), and Leiter-R ($\beta = .39$) scores were not significant predictors. Collectively, age and scores from the SPELT-3, TACL-3, Leiter-R, and CARS-2 account for 69% of the variance in whether a participant became a PU for the person form.

Because our measure of ASD severity was missing data for one participant, we conducted the same regression analyses above omitting the CARS-2 variable. Thus, the analyses included all 17 participants. When all participants were included in the analysis, the model for the gender form, $R^2 = .24$, $F(1, 17) = 4.77$, $p = .04$, was statistically significant. This supports findings from the primary research question. When instruction type was held constant and the age, language ability, and cognitive ability variables were added, the model was no longer significant, $R^2 = .37$, $F(4, 17) = 0.56$, $p = .69$. Language ability, cognitive ability, and age did not significantly predict whether a person became a PU for the gender form; however, when these variables were added to the regression model, teaching type was no longer significant. Whether a person was taught using an explicit–implicit approach did predict whether a person became a PU ($\beta = .41$), accounting for 24% of the variance when developmental variables were not included in the model.

For the person form, the initial model was not statistically significant, $R^2 = .29$, $F(1, 17) = 0.96$ $p = .34$. This finding is also consistent with our results for the primary research question. There was a significant *F* change when a second model was built with age, language ability, and cognitive ability variables, $R^2 = .69$, $F(4, 17) = 5.85$, $p < .01$. Results indicated that, while instruction type did not significantly predict PU status ($\beta = .29$), performance on the TACL-3 was a significant predictor ($\beta = .53$, $p = .03$). The age ($\beta = .35$), SPELT-3 ($\beta = .46$), and Leiter-R ($\beta = .37$) variables were not significant predictors (all *p* values > .05).

Discussion

Few studies exist that have evaluated interventions targeting grammatical weaknesses of verbally expressive children with ASD. The studies that do exist have used varying levels of explicit instruction with some success (Fischer et al., 2010; Hendler et al., 1988). The current early efficacy study was designed to examine the efficacy of an intervention approach that combined implicit modeling and recasting approaches with explicit instruction in which the pattern guiding the targeted form was directly presented. Previous studies (Finestack, 2018; Finestack & Fey, 2009) found a learning advantage with such an approach for children with PLI. Thus, the current study was an extension of both studies, and included 17 children who had been previously diagnosed with ASD and demonstrated weaknesses in grammar ability on standardized measures.

Our primary research question asked whether children with ASD demonstrate an advantage in learning novel grammatical forms when taught using an explicit approach in addition to implicit approaches. The participants completed two interventions, one with combined explicit–implicit instruction and the other with implicit-only instruction (order was randomized), targeting two unique novel grammatical forms. Klinger et al. (2007) found that children with ASD had weaker performance on implicit tasks than TD children, with no differences on explicit tasks. Thus, we predicted that the explicit–implicit instruction would be more efficacious because it encouraged children with ASD to utilize a rule-bound pattern when given specific examples of a novel language form. In contrast, we predicted that the implicit-only instruction would emphasize weaknesses in implicit learning among children with ASD and preclude them from accurately applying the novel pattern when only provided models and recasts of target forms. With explicit–implicit instruction, six of 17 participants became PUs (achieved 80% accuracy of target forms), whereas only one of 17 participants became PUs with implicit-only instruction. Using within-participant related samples analysis, a statistically significant effect for explicit–implicit instruction over implicit-only instruction was not found. Despite the lack of a statistically significant difference, a corresponding medium effect size indicates clinically significant differences.

The novel markings used in this study included a gender marking and a person marking. The gender marking was more semantically based and less complex than the novel first-person singular marking. The marking of person requires referential awareness, similar to pronoun use. Personal pronouns are particularly difficult intervention concepts for many children with ASD due to their changing referential nature based on social context (Hendler et al., 1988; Tager-Flusberg et al., 2005). For the gender form, participants demonstrated a statistically significant advantage with explicit–implicit instruction relative to implicit-only instruction. Embedding the rule into the intervention appeared to improve accuracy on this form. This advantage was not found for the person target form.

The one participant who became a PU with implicit-only instruction when targeting the person novel form also became a PU when targeting the gender novel form with explicit–implicit instruction. The researchers investigated potential factors contributing to his learning success and found that, relative to the sample, this participant had higher expressive language, receptive language, and nonverbal IQ standard scores (108—second highest, 94—sixth highest, and 133—second highest, respectively). This could suggest that implicit-only and explicit–implicit instruction may be equally beneficial for children with stronger language and cognitive ability. This was addressed further in the results associated with Secondary Research Question 2.

Secondary Research Question 1 addressed the generalization and maintenance of accuracy of target forms in the group of children who became PUs. We predicted that more children who became PUs with explicit–implicit instruction would remain PUs during 1-week follow-up maintenance sessions than children who became PUs with implicit-only instruction. Of the six participants who became PUs with explicit–implicit instruction, four remained PUs for the maintenance follow-up. The one participant who became a PU in the implicit-only instruction condition also remained a PU for the maintenance follow-up. The change in PUs across teaching groups was not significant, and because the only implicit-only PU was able to maintain accuracy, it made inferences about maintenance difficult.

We also predicted that with explicit–implicit instruction, more participants would demonstrate generalization of the target forms to a toy-based activity than children who received implicit-only instruction. Generalization across contexts from computer-based to toy-based was not as high as the researchers expected, with only four participants able to maintain PU accuracy on the Generalization Probe. Recall that when compared across instruction groups, six participants were able to become PUs with explicit–implicit instruction, and one participant became a PU with implicit-only instruction. In the toy-based Generalization Probe, four participants remained PUs. Of those four, three received explicit–implicit instruction and one received implicit-only instruction. These differences were not statistically significant. The implicit-only PU was also a PU in the explicit–implicit condition. This participant was able to maintain PU status during the 1-week follow-up Maintenance Probe and toy-based Generalization Probe under both teaching conditions and was the only one to do so. The toy-based Generalization Probe occurred 1-week postintervention directly following the Follow-up Maintenance Probe. We, therefore, cannot say with certainty whether or not the drop in PUs was due to a lack of maintenance over time or generalization across contexts.

Secondary Research Question 2 addressed the existence of differences between the groups of children who achieved mastery criterion, and those who did not based on their age, language, cognitive, and behavioral profiles, when teaching type was held constant. Results of logistic multiple regression analyses indicated that when learning the gender form, instruction type, age, language and cognitive ability, and ASD severity did not predict participant posttreatment PU status. When the ASD severity measure was removed from the model due to missing data, teaching type became a significant predictor of variance in pattern use in the initial model. The developmental variables (age, language, and cognitive ability) remained nonsignificant, and the overall model was also nonsignificant. This is congruent with previous findings by Finestack and Fey (2009) in which the children in their sample of children with PLI did not demonstrate different language and cognitive profiles across PU and Non-PUs. However, regression analyses for the person form did yield a significant model in which instruction type was not a predictor of variance in pattern use, but receptive language ability (as measured by TACL-3) was a significant predictor. It appears that children who were able to learn the novel form had higher receptive language abilities.

Study Limitations and Future Directions

The findings from this study must be qualified in several ways. First, the sample size was relatively small and represented a homogeneous group of children with ASD. Despite the small sample size, a statistically significant advantage emerged for the explicit–implicit approach compared to the implicit-only approach for the novel gender target form. Overall, the sample represents a unique nondiverse subset children with ASD. Although the range of severity of ASD symptoms was broad, the sample mostly represented those with mild–moderate symptoms of ASD. Moreover, the participants' mothers, who reported on their highest level of education, included mostly those with graduate and bachelor's degrees. Only one mother reported having no education post–high school graduation. Finally, all of the participants were identified as non-Hispanic White, which confines the generalizability of our findings. The inclusion of a more diverse sample of children will be a high priority for subsequent studies in this area to make more precise conclusions regarding the generalizability of treatment outcomes.

Another study limitation that requires attention is the relatively strong expressive language abilities of the children with ASD. Because the eligibility criteria included up to a standard score of 95 on the SPELT-3, this group of children with ASD was possibly more capable with grammatical morphemes than the general population of children with comorbid ASD and language impairment. This criterion was used, as noted in the Method section, because of Spaulding et al. (2006) and Perona, Plante, and Vance (2005) findings that it is a good cutoff for determining grammatical impairment. However, it further limits our sample of children with ASD.

Of further concern is that very few participants actually became PUs (six out of 17); thus, we examined the effect of our criterion cutoff. Inspection of trends in PU accuracy displayed in Figure 5 appears to support the 80% threshold as a mastery level criterion. One participant who achieved 75% as their highest level of accuracy did not trend toward PU accuracy levels (in fact, trended toward decreased accuracy). Those below 75% tended to perform around chance levels. It is also important to note that not all children who achieved 80% maintained this accuracy across sessions.

The relatively limited number of participants who became PUs could be due to several reasons. We included a large age range, with children aged 4–9 years. All of the PUs, in both teaching conditions, were either 6 or 7 years old. These were the older children in the cohort with the exception of one 9-year-old who failed to become a PU in either teaching condition. This could suggest that this intervention may be more appropriate for older children. However, it could also be the case that the younger children require a more intense dosage of treatment. Consequently, another qualification is the limited number of intervention sessions that each participant completed and the number of teaching episodes between explicit rule presentations within sessions. Participants were exposed to each novel grammatical marking in no more than four treatment sessions. Each child completed a maximum of 64 teaching episodes for each grammatical marking. Thus, the cumulative treatment intensity of the current intervention was very low. It is possible that if we had extended the number of intervention sessions, or increased the dose of teaching episodes within each session, more participants would have become PUs. Most language intervention programs in a clinical setting include more than four sessions. Fischer et al. (2010) reported a range of 399–1320 training trials to establish generalized responses to targeted sentence syntax in four young children with ASD. Thus, it is impressive that six children were able to reach 80% or higher accurate use of the novel form in such a limited intervention period. Future research should examine the relative treatment intensity parameters required for a child to reach a high accuracy level of PU in each intervention condition. It is also unknown how many times the explicit rule guiding target forms should be presented. In this study, participants who received explicit–implicit instruction heard the explicit rule total of six times presented intermittently during the Teaching and Feedback Tasks. Future research should examine the most efficacious and efficient rule presentation schedule to use in intervention.

A final qualification is the contrived nature of the targets, which were novel forms that do not exist in the English language. It is unknown if the children would have demonstrated greater or less learning if the targets were true grammatical forms, such as past tense *–ed*. We chose to teach novel grammatical morphemes to use the same targets and pedagogy across children. The use of novel forms also ensured that the participants had not previously encountered the form and that differences in past and current clinical services were not confounding factors. We did not expect to observe gains in any "real-life" communicative or cognitive contexts. Conversely, in our attempt to control for confounding variables, the lack of social validity could have itself been a confounding variable in acquisition of the novel grammatical morphemes.

Conclusions

The purpose of this early efficacy study was to evaluate an explicit–implicit instructional approach to teach novel grammatical morphemes to children with ASD who demonstrate deficits in grammatical ability. Results are consistent with previous findings that demonstrate an advantage for an explicit–implicit intervention approach when targeting grammatical forms and expands upon previous study designs by including children with ASD with weaknesses in the development of grammatical forms. However, further research is needed that includes a larger, more diverse pool of participants to provide more conclusive results. Study results support the continued examination of using explicit approaches that present the rule guiding target forms when teaching true grammatical forms (i.e., past tense *–ed*, third-person singular) to children with ASD.

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