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A multi-phase assessment for selecting an augmentative and alternative communication modality

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ABSTRACT

Children with autism, who have limited speech, are often candidates for augmentative and alternative communication (AAC) modalities to learn basic mands. However, few studies have evaluated the assessment of AAC modalities. We report on the results of an evidenced-based multi-phase assessment, with a focus on choice as a foundational element, to evaluate modality selection, comparison, and acquisition for six children with autism. Assessment procedures involved using an indirect assessment that evaluated environments and the caregiver's preference as a listener. The results of the indirect assessment informed the experimental evaluation of learner acquisition and preference for a modality. Findings indicate that the assessment process is relatively quick, the child participants did demonstrate a preference for a mand modality, and the child participants were able to meet mastery criteria for the use of the initial mand. Results point to a potentially useful approach for assessing AAC modalities for young children with autism.

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Children with autism spectrum disorder (ASD) and other related developmental disabilities (DD) often have a comorbid communication disorder, which may result in limited spoken communication or complex communication needs (Centers for Disease Control and Prevention, 2020). Although, arguably, vocal speech may be a highly acceptable modality for social communication, when speech challenges persist for individuals, augmentative and alternative communication (AAC) systems can be advantageous in promoting the development of communication repertoires. There are a variety of modality options used within the context of AAC interventions, such as unaided modes (e.g., manual sign), aided low-tech options (e.g., picture exchange; PE), or high-tech options (e.g., speech-generating devices; SGDs). Often, interventions selected to establish the use of AAC systems involve teaching basic mands (i.e., requests) for preferred items (Allen et al. (2017); Carnett et al. (2021); Gevarter et al. (2013); Neely et al. (2022)). Teaching communication repertoires using an AAC modality is well

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established, with research supporting the positive outcomes for children with ASD (see reviews by Gevarter et al., 2013; Morin et al., 2018; van der Meer et al., 2011).

What is less established is how to select the AAC modality for initial programming (Carnett et al., 2021; Schlosser & Raghavendra, 2009). There are many factors that might contribute to the selection of an AAC modality (Carnett et al., 2021; Schlosser & Raghavendra, 2009). For the learner, factors to consider include learner preference (Couper et al., 2014; Ringdahl et al., 2018, Windborn-Kemmerer et al., 2009; van der Meer et al., 2011), learner proficiency with the modality (Kunnavatana et al., 2018), co-morbid problem behavior (e.g., Ringdahl et al., 2018), prerequisite skills (presence of vocal speech; Valentino et al., 2019), and exposure to multiple modalities during acquisition (Lorah, 2016). For the listener (e.g., communication partner), some considerations include their preference, the perceived intelligibility and effectiveness of the modality (Achmadi et al., 2015; Broadhead et al., 2020), and resources needed to maintain the AAC system (Newton et al., 2007; Zinkevich et al., 2022). However, it should be noted that listener considerations are complementary to AAC user considerations and, when included, contribute to a holistic and individualized approach (Broadhead et al., 2020; Carnett et al., 2019). Ultimately, the identification of an AAC modality must be individualized with opportunities for choice, preference, and the embedding of socially acceptable practices (Autistic Self Advocacy Network, 2022; Ferguson & Milne, 2023).

Despite the notion that AAC interventions are often described as an evidence-based practice (EBP; Steinbrenner et al., 2020; Wong et al., 2015), it is important to distinguish the technology (AAC systems) from the practices used to assess and support acquisition of the AAC modality (Lorah et al., 2022). EBP has been further defined in the literature as a model of professional decision-making to aid practitioners in using the best available evidence incorporated with client values, context, and clinical expertise to provide high-quality services (Slocum et al., 2014). It is important to recognize that EBPs should not be isolated to interventions but also inclusive of assessment practices. However, there is a lack of guidance on an assessment model to aid in determining which AAC modality may best suit an individual to establish an initial communication repertoire.

The purpose of this feasibility study is to evaluate a preliminary multi-phase assessment protocol for selecting an initial AAC modality. Given the importance of user and listener ratings of acceptability in long-term adherence, this study focuses on evaluating dimensions of social validity: (1) caregivers and child choice of modality, (2) time for assessment, (3) acceptability as rated by caregivers, and (4) long-term communication outcomes for the child participants, to evaluate the overall acceptability of the assessment. This study is the first step in developing and refining an assessment protocol that can be adopted to operationalize procedures for practical applications.

Method

The current study was within the context of a larger host study. Recruitment for this study was from the larger cohort, with participants opting into this study based on the inclusion criteria below. Children were eligible for the study if they were: (1) between 12 and 36 months of age at the start of the study, (2) met criteria to be identified as at-risk for ASD (see description below), (3) had complex communication needs that impeded on their daily lives (e.g., unable to make basic requests,

Table 1. Participant demographic information.

Participants	Age	Gender	Ethnicity/ Race	Primary Language	Inclusion Criteria
Estella	2 yr:4mos	F	Hispanic	English	At-risk for ASD due to MCHAT score of over 3
Janie	2 yr:1mon	F	Hispanic	English	At-risk for ASD due to MCHAT score of over 3
Angel	2 yr:3mos	F	Hispanic	English	At-risk for ASD due to MCHAT score of over 3
Amanda	1 yr:7mos	F	Hispanic/ White	English	At-risk for ASD due to sibling w/ASD
Cameron	2 yr:10mos	M	White	English	At-risk for ASD due to MCHAT score of over 3
Erin	2 yr:9mos	F	White	English	At-risk for ASD due to sibling w/ASD

engaged in problem behavior), and (4) had a caregiver that provided informed consent to participate in the project. Participants qualified as "at-risk" for autism if they had an older sibling diagnosed with ASD. They also could qualify as "at-risk" between the ages of 18–23 months if they received a nine or higher on the APSI (Autism Parent Screen for Infants; Bryson et al., 2008) or a score of 3 or higher on the MCHAT-R/F (Modified Checklist for Autism in Toddlers – Revised, with Follow-Up; Robins et al., 2014). Participants, 24–36 months, could also qualify as at-risk if they received a score of three or higher on the MCHAT-R/F (Modified Checklist for Autism in Toddlers – Revised, with Follow-Up; Robins et al., 2014). Table 1 provides each participant's scores. All of the assessments were conducted by a physician with clinical and research expertise in autism diagnoses and research training in the assessments.

Participants

Six young children with ASD participated in this study (see Table 1). All participants were reported to have no concerns for vision or hearing and had been carried to full term, except Angel who was pre-term. All participants had yet to develop one-word mands and were new to applied behavior analytic (ABA) interventions. Assessments conducted by the medical team included the MCHAT (M-CHAT; Robins et al., 2014) and the Vineland Adaptive Behavior Scales (Vineland-III; Sparrow et al., 2016). The lead researchers and authors also conducted the Verbal Behavior Milestone Assessment Placement Program (VB-MAPP; Sundberg, 2008) to document their current verbal behavior repertoire and general functioning abilities. Direct assessment sessions were within the context of naturalistic play, with two or three assessment sessions. Each session lasted approximately 45 min.

Estella was a 2-year 4-month-old girl scoring within the high-risk range on the MCHAT. On the Vineland-II, she scored a raw score of 11 (0:07 age equivalence) on the receptive domain and 7 (0:02 age equivalence) on the expressive domain, which indicated moderately low adaptive functioning. She scored within the adequate range (1:10 age equivalence) for fine motor skills, indicating she would have the motor abilities needed to use various AAC options (see Table 2). On the VB-MAPP, she was rated at a beginning level one range (see Table 3). For example, for her manding repertoire, she could engage in gaze shift and point and gesture to obtain reinforcers but could not emit a mand using an AAC mode or engage in functional vocal speech. Further, on the Early Echoic Skill Assessment (EESA) component of the VB-MAPP, she scored a zero. Estella's

Table 2. Participant assessment information; Vineland assessment.

	Summary of the age equivalence scores for each participant					
Domains	Participants					
	Estella	Janie	Angel	Amanda	Cameron	Erin
Communication	Low	Moderately Low	Low	Adequate	Low	
Receptive	0:7	0:8	0:7	1:0	0:11	1:0
Expressive	0:2	0:10	0:11	1:0	0:11	1:0
Socialization	Low	Moderately Low	Moderately low	Adequate	Adequate	
Interpersonal Relationships	0:3	0:6	0:7	1:0	1:4	0:4
Play and Leisure	0:07	1:3	1:3	:10	1:11	1:5
Motor Skills	Adequate	Adequate	Adequate	Adequate	Moderately low	Moderately high
Fine Motor	1:10	1:7	1:8	1:5	1:8	2:2

Note. Adaptive levels are categorized by the following qualitative descriptions: low, moderately low, adequate, moderate high, and high.

Table 3. Participant assessment information; VB-MAPP.

	Summary of the domain scores for each participant					
Domains	Participants					
	Estella	Janie	Angel	Amanda	Cameron	Erin
Mand	.5	1	.5	1.5	0	2.5
Tact	0	0	0	0	0	0
Listener	1.5	1	2.5	3	.5	3.5
Motor	3	0	2	1.5	.5	4
ESSA	0	4.5	10	5	1.5	8.5

mother reported she had previous exposure to "baby sign" but did not use it functionally or consistently.

Janie was a 2-year-1-month-old girl at high risk of having autism, as indicated by her MCHAT score. On the Vineland-III, she scored a raw score of 15 (0:08 age equivalence) on the receptive domain and 15 (0:10 age equivalence) on the expressive domain, which indicated low adaptive functioning. She scored within the adequate range (1:7 age equivalence) for fine motor skills, indicating she would have the motor abilities needed to use various AAC options (see Table 2). On the VB-MAPP, she scored within the beginning level one range (see Table 3) and had a very low EESA score (4.5 raw score).

Angel was a 2-year 3-month-old girl at high risk of having autism, as indicated by her MCHAT scores. On the Vineland-III, she scored 12 (0:7 age equivalency) on the receptive domain and 16 on the expressive domain, which indicated low adaptive functioning. She scored within the adequate range (1:8 age equivalence) for fine motor skills, indicating she would have the motor abilities needed to use various AAC options (see Table 2). On the VB-MAPP, she was rated at an emerging level one, meaning she was functioning at an age equivalency of about six months regarding her language development (see Table 3). Angel's mother reported previous exposure to "baby sign" but did not use it functionally or consistently.

Amanda was a 2-year 3-month-old girl at high risk of having autism. On the Vineland-III, she scored 25 (1:0 age equivalence) on the receptive domain and 18 (1:0 age equivalence) on the expressive domain, which indicated adequate adaptive functioning. She scored within the adequate range (1:5 age equivalence) for fine motor skills,

indicating she would have the motor abilities needed to use various AAC options (see Table 2). On the VB-MAPP, she scored within the range of mid-level one (see Table 3).

Cameron was a 2-year 10-month-old boy at high risk of having autism, as indicated by his MCHAT scores. On the Vineland-III, he scored 21 (0:11 age equivalence) on the receptive domain and 16 (0:11 age equivalence) on the expressive domain, which indicated low adaptive functioning. For fine motor skills, he scored within the moderately low (1:8 age equivalence; see Table 2). However, during initial observations of his play behaviors, he was observed using fine motor skills to activate a variety of toys. He did not show any major deficits that would impact his use of AAC options. On the VB-MAPP, he was scored within the range of mid-level one (see Table 3).

Erin was a 2-year 3-month-old girl at high risk of having autism, as indicated by her MCHAT scores. On the Vineland-III, she scored 24 (1:0 age equivalence) on the receptive domain and 17 (1:0 age equivalence) on the expressive domain, which indicated adequate adaptive functioning (see Table 2). On the VB-MAPP, she was rated at mid-level one, except for the motor domain score, which was high (see Table 3). Erin's mother reported previous exposure to "baby sign" but did not use it functionally or consistently.

Setting and sessions

All sessions were in a university-based clinic with child-sized chairs, tables, and shelves. Each session consisted of 5 trial blocks, randomized to one of the two AAC modalities identified by the parents as a potential communication modality during the indirect modality decision-making assessment (Figure 1; Step 2). A brief preference assessment probe occurred before the start of each session to identify a preferred item targeted for the mands during the session. Each session lasted approximately 10 min.

During sessions, participants sat near the researcher either at the table or on the floor, and a second experimenter sat a few feet away on the other side of the room to film the session. A second researcher later coded videos to assess the reliability of data collection and implementation fidelity. For each participant, the direct assessment of the modalities phase (Figure 1; Step 3) consisted of 30 trials. An average of nine (*range*: 5 to 16) sessions were conducted for the modality teaching phase (Figure 1; Step 4), consisting of five trials using the modality identified from the direct assessment phase.

AAC modalities

An Apple iPad® mini equipped with the speech synthesizing application Proloquo2Go® (McNaughton & Light, 2013; Sennott & Bowker, 2009), picture exchange (PE) symbols, and/or sign language were considered for modality assessment. Further, for the SGD, individualized icons were created based on those identified during the preference assessment and added to the Proloqu2Go® library by taking photographs of the corresponding items. Proloquo2Go® was selected for this study since it is a commonly cited app within the literature and allows for programming child-specific photographs of stimuli. For the PEs, symbols consisted of laminated photographs of the preferred items. A small plastic folder with Velcro on the top outside cover was used to place the corresponding PE during the sessions. For both modalities, only one picture symbol was presented either on

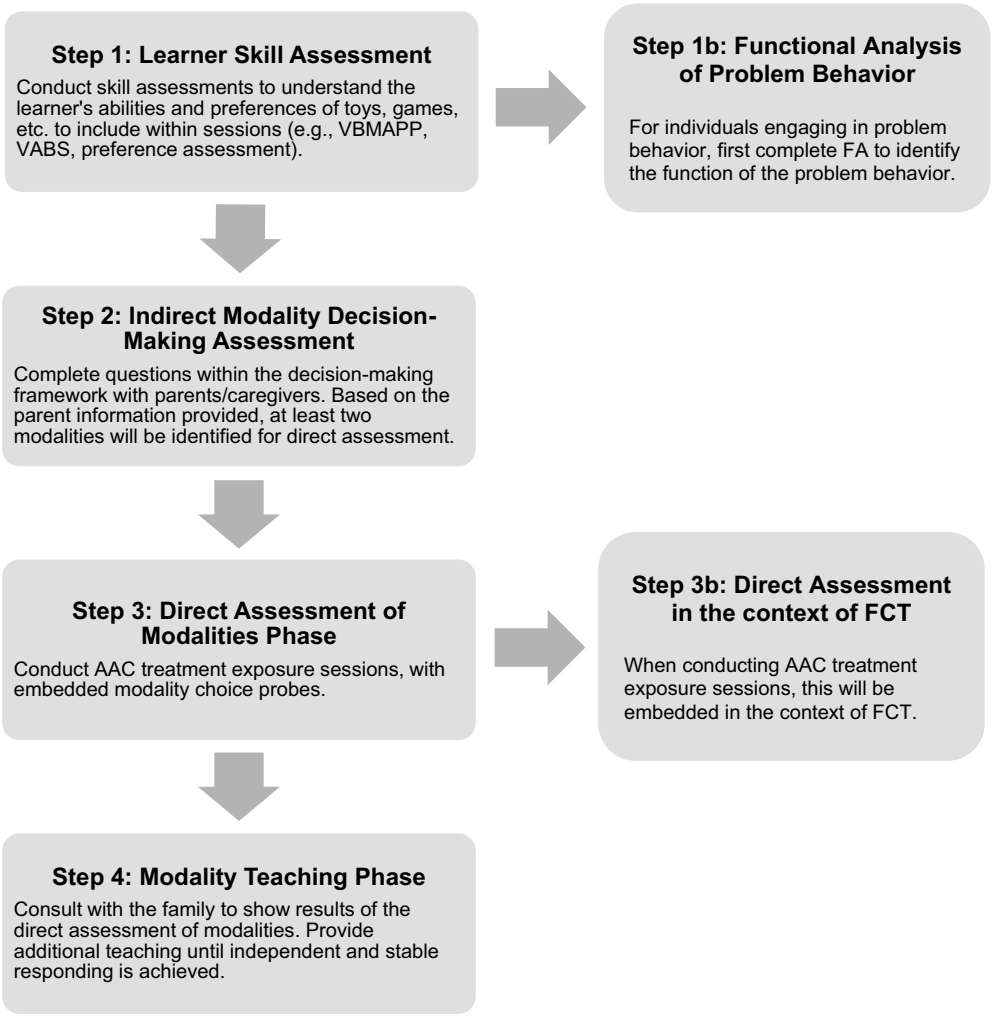

Figure 1. Assessment process overview.

the front cover of the PE folder or the screen of the SGD. Images used for each participant were identical in size and format for both AAC modes (approx. 100 × 65 mm).

Response definition and data collection

The dependent variable was defined as the participant producing a mand using the targeted modality. For SGD-based mands, this was defined as the child pressing the corresponding picture icon on the device to activate the digitized speech. For PE-based mands, this was defined as the child picking up and handing the corresponding picture card to the researcher. For sign, this was defined as physical movement to form the corresponding sign or close approximation of the corresponding item. If a prompt was used to evoke the mand, the level of prompting used was recorded. Responses were coded as independent if

the participant emitted the mand (e.g., exchanging a PE with the experimenter, pressing and activating the digitized speech on the SGD) within 10 s of manipulating the establishing operation (EO).

Four participants (i.e., Angel, Amanda, Cameron, and Erin) also engaged in problem behavior; thus, their sessions were conducted in the context of functional communication training (FCT). Angel, Amanda, Cameron, and Erin engaged in *screaming* behavior, defined as high-pitched vocalizations above a conversational level. Angel, Amanda, Cameron, and Erin engaged in *flopping* behavior, defined as any instance of dropping to the floor from a standing or sitting position with stomach, back, limbs, or bottom contacting the ground. Amanda and Erin engaged in *crying* behavior defined as whining/vocalizations above conversational level. In addition to the above behaviors, Angel also engaged in *aggression*, defined as any instances of hitting or kicking another person, and Amanda engaged in *self-injurious* behavior, defined as flopping to the floor and banging her head and limbs against hard surfaces.

Although problem behavior was recorded for these four participants during sessions, only summary data is provided since the primary dependent variable is related to the functional communicative response (FCR) based on each participant's FA results.

Across the sessions, data were collected using an observational trial-based method with paper and pencil. For each trial, the observer recorded a plus sign or minus sign on a paper data sheet to indicate the presence or absence of the target behavior (e.g., mand or problem behavior) and the presence or absence of problem behavior for the four participants who engaged in problem behavior (i.e., Angel, Amanda, Cameron, and Erin). Additionally, for trials where the mand was prompted, the level of prompt was also recorded.

Development of multi-phased assessment

To develop the steps of the multi-phase assessment, the authors first reviewed the literature on initial acquisition of AAC modalities. Specifically, we looked at comparative studies established in the literature and systematic reviews published across the topic and related areas. Next, we evaluated AAC studies that focused on elements of social validity related to the listener. After reviewing the evidence, a flow chart of the steps included in the multi-element assessment was developed (Figure 1). This was followed by a decision-making flow chart to help guide a conversation with the parent and caregivers when discussing possible AAC modality options (Appendix A).

Procedure

This study was conducted in four steps (see Figure 1). Step one included conducting a skill and preference assessment. Researchers also conducted a functional analysis for the four children who engaged in problem behavior. In step two, the researcher administered an indirect AAC decision-making assessment. In step 3, the researcher utilized an A-B-A-B design with choice probes and teaching to acquisition phase to compare two AAC modalities during acquisition (Gast & Ledford, 2009). This comparative design was selected to evaluate the rate of acquisition and response to prompts across the two

modalities while accounting for the potential emergence of learner preference to assess the most viable and preferred AAC modality. In Step 4, the researchers used the preferred AAC modality to teach manding to acquisition.

Functional analysis

Upon caregiver report of problem behavior, researchers administered the Questions About Behavior Function (QABF; Paclawskyj et al., 2000) assessment and interviewed caregivers. Based on the results of the QABF, the researchers conducted a brief trial-based functional analysis (TBFA) as outlined by Rispoli et al. (2015) and adapted by Neely et al. (2022). The TBFA consisted of 15 trials for each of the hypothesized functions (i.e., access to caregiver attention, access to preferred items, and escape from non-preferred activities). Each trial consisted of 1 min. control followed by a 1 min. test condition. Trials did not begin until the child had ceased behavior for at least 3 mins.

Results of the TBFA indicated that Angel's problem behavior was maintained by escape from demand and access to tangibles. Amanda, Cameron, and Erin's behaviors were maintained by access to caregiver attention. These results were used to identify the target mands for FCT.

Preference assessment

For participants who did not engage in problem behavior (i.e., Estella & Jamie), preferred activities were identified by conducting a two-part preference assessment (Kang et al., 2013). Specifically, caregivers were interviewed using a modified Reinforcer Assessment for Individuals with Severe Disabilities (RAISD; Fisher et al., 1992) to obtain a list of potentially preferred activities. This was followed by a direct preference assessment using a pairwise preference assessment protocol (Fisher et al., 1992), in which activities identified from the RAISD were systemically presented in pairs, covering all possible combinations. For each trial of the pairwise preference assessment, the item that the child selected was recorded. A total of two or three sessions were conducted for each participant, and each session consisted of 10 trials. The results of the pairwise preference assessment identified high-preferred items to be used during sessions. Further, before each modality teaching session, a brief multiple-stimulus assessment of the top three items identified items via the pairwise assessment was conducted to account for the momentary preference of each participant. For Estella, her top items included pretend food toys, an elephant ball popper toy, and snacks from home (e.g., crackers and cereal). For Janie, crayons, coloring books, stickers, and snacks from home were identified as her preferred items.

Indirect AAC decision-making assessment

Before assessing the use and individual choice of AAC modalities, each caregiver consulted with the first or second author and discussed the strengths and weaknesses of the various AAC modalities. This was done using a decision-making framework (see Indirect Modality-Decision Making Assessment in Appendix 1) to help guide the discussion on possible benefits and limitations associated with AAC modalities and to help focus on the learner's repertoire, needs, preferences, and prior learning history to identify best fits options of AAC mode. The decision-making framework consisted of yes and no questions across each modality. During

the discussion, these questions were used as a guide to discuss the child's current abilities and learning history in the context of each modality option to help identify at least two possible modality options for direct assessment. Listener abilities and preferences were also included within the framework to help promote social validity. This step aimed to identify two potential modalities for consideration in the direct assessment phase. For all of the participants, the caregivers selected SGD and PE as two potential modalities for consideration.

Direct assessment of AAC modalities

For each session, the following variables remained constant: (a) time of day, (b) use of identified stimulus/EO for manding, and (c) presence, location, and display of the SGD or PE for children using one of those modalities. For participants without problem behavior (i.e., Estella & Jamie), directly before the session, a brief stimulus preference probe was conducted to identify stimuli (e.g., toys, snacks, games) that could be used to contrive the learner's motivating operation (MO) to evoke mands. For participants with problem behavior (i.e., Angel, Amanda, Cameron, & Erin), the EO for the problem behavior identified from the FA was used to teach the targeted mand in the context of FCT. Additionally, each session was quasi-randomized, having no more than three sessions in a row across the two modalities identified in the indirect modality assessment. Each session consisted of five manding trials using one modality, followed by a brief modality choice probe. During the manding trials, the modality was present, and the experimenter manipulated the item (e.g., engaged with the toy) or manipulated the EO for problem behavior until the participant engaged in a behavioral indicator of motivation, such as reaching and trying to obtain the item or engaging in problem behavior. Upon observation of a behavioral indicator of motivation (e.g., reaching for an item), a second experimenter provided graduated guidance prompting to establish the response. The prompting included a full physical prompt, a partial physical prompt, and a gestural prompt. Within each session, the prompt level was faded as quickly as possible to support independent responding. Access to reinforcement, contingent on manding at any prompting level, was provided during the trials. If the child did not indicate interest in the item (e.g., reaching for the item), the session was terminated, and preference was re-evaluated; however, it should be noted that these procedures were not necessary for any of the participants in this study.

Following every fifth treatment exposure session (i.e., five-trial block), a brief choice of modality probe was conducted to evaluate the emergence of participant preference for a modality option. A total of six choice probes were conducted for each participant. Probes were conducted similarly to the treatment exposure sessions in that an item identified as a potential reinforcer was made available but out of reach to arrange an opportunity for manding. However, both modalities used during the treatment exposure sessions were in front of the child. If the child reached for one of the modalities, this indicated a choice of modality. Independent responses, using either modality, were reinforced by the characteristic consequence (e.g., if the child independently exchanged the PE, they were provided access to the corresponding stimuli). If the child reached towards, touched, or picked up one of the available modalities but did not independently engage in the targeted motor behavior associated with the modality (e.g., touch, pressed, and released their finger on the touch screen of the SGD to activate the digitized speech)

after indicating their choice, most-to-least prompting hierarchy was used to evoke the correct response. If, within 10 seconds, a choice of modality was not indicated, the trial was terminated, and a "no choice" was recorded. Since modality choice probes were conducted throughout the modality exposure phase, prompting to activate the AAC modality was provided to ensure their behavior associated with manding was not placed on extinction.

Teaching to acquisition phase

Following the completion of the modality assessment phase, a teaching-to-acquisition phase was provided to evaluate the effects of the teaching one modality to acquisition (i.e., 100% independent responding across three sessions). The decision-making for this phase was informed by the level of independent responses during the direct assessment phase, occurrences of problem behavior, and possible emergence of learner preference. In cases where a clear preference did not emerge, we relied on the learner's level of independent responding. Further, parents were also consulted with and shown the assessment phase data to confirm which modality would be used during the teaching phase. Each session consisted of five trials that were similar to the direct assessment sessions: a brief preference assessment was conducted before the session or use of EO identified from the FA, most-to-least prompting with prompt fading, and reinforcement of all mands at any prompt level. Sessions were conducted until acquisition was achieved.

Acceptability of the modality assessment

At the conclusion of the assessment, the Treatment Acceptability Rating Form – Revised (TARF-R; Reimers et al., 1991) was administered to the caregivers as a measure of social validity for the mand modality assessment and treatment. The modified form included 20 questions. Example questions included "How clear is your understanding of this treatment?", "How acceptable do you find the treatment to be regarding your concerns about your child?" and "How willing are you to carry out this treatment". Due to a technical error in administration, the responses were presented on a Likert scale from 1 to 5, with "1" corresponding to strong disagreement and "5" corresponding to strong agreement (e.g., not at all clear to very clear, not at all acceptable to very acceptable, not at all willing to very willing, etc.). These scores were then transposed to the original 7-point scale of the assessment tool to be consistent with previous reporting of this tool.

Time to completion

Across each phase of the assessment (i.e., caregiver interview, direct modality assessment), the following formula was used to calculate the average amount of time for assessment completion: [sum of assessment time for each participant]/[total number of participants].

Follow-up

One year after participation, the research coordinator reached out to the families to: (1) if the child had received a later diagnosis of autism and what level of autism they were diagnosed with, (2) if the child had developed vocal communication skills, and (3) if the child was still using their selected modality of communication.

Inter-observer agreement

For each phase, a second independent observer collected data on the participant's responses and the level of prompting used during each trial within the session. Agreement was scored if the experimenter and the independent observer had recorded the same level of prompting or if an independent response was recorded. Any discrepancy was counted as a disagreement. The following formula was used to calculate a percentage of agreement for each session and each participant: [Agreements/[Agreements + Disagreements]] x 100%. For Estella, the independent observer collected data on 30% of the mand modality assessment trials with a mean agreement of 100%. During the teaching to acquisition phase, IOA was collected for 36% of the sessions with a mean agreement of 95%. For Janie, IOA was collected on 30% of the mand modality assessment trials with a mean agreement of 90%. During the teaching to acquisition phase, IOA was collected for 50% of the sessions with a mean agreement of 92%. For Angel, an independent observer collected data on 30% of the mand modality assessment trials with a mean agreement of 100%. During the teaching to acquisition phase, IOA was collected for 60% of the sessions with a mean agreement of 93%. For Amanda, an independent observer collected data on 30% of the mand modality assessment trials with a mean agreement of 100%. During the teaching to acquisition phase, IOA was collected for 50% of the sessions with a mean agreement of 99%. For Cameron, IOA was collected on 30% of the mand modality assessment trials with a mean agreement of 100%. During the teaching to acquisition phase, IOA was collected for 38% of the sessions with a mean agreement of 94%. For Erin, IOA was collected on 30% of the mand modality assessment trials with a mean agreement of 100%. During the teaching to acquisition phase, IOA was collected for 60% of the sessions with a mean agreement of 97%.

Procedural fidelity

During the trials/sessions where IOA was collected, researcher procedural fidelity was assessed using a checklist describing the procedures corresponding to the phase. The percentage of correctly completed steps was calculated for each session. The mean percentage of correct implementation across trials during the mand modality assessment phase was 100%, and during the teaching to acquisition phase, 100% across all participants.

Results

For each participant, results from the indirect AAC decision-making assessment identified either the use of PE or an SGD as a potential modality. These two modalities were then tested through direct assessment. Figures 2 and 3 display the graphed data for the mand modality assessment sessions, teaching to acquisition sessions, and allocation of choice for Estella and Janie. Figures 4–7 display the graphed data for the participants who engaged in problem behavior (i.e., Angel, Amanda, Cameron, Erin). For these participants, graphed data for problem behavior is also provided.

Estella (Figure 2) had some response variability across the two modalities in the exposure phase. Initially, independent responses were observed with the SGD; however, this was not maintained in subsequent trials. For the PE responses, stability in trend was observed on the twenty-fifth trial (after 11 exposure trials). Overall, Estella required less

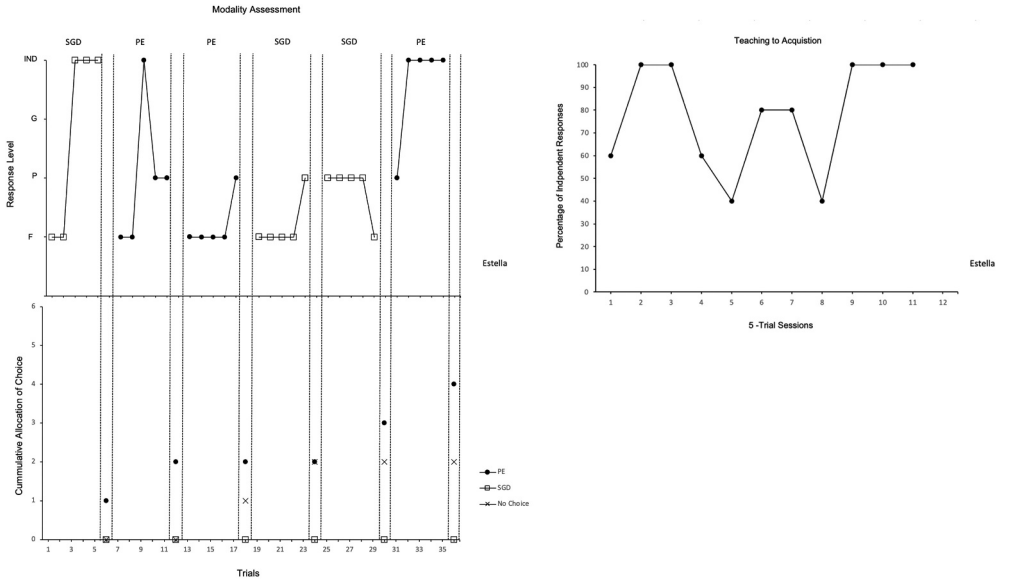

Figure 2. Results for Estella. *Note*. For the first panel, the Y axis (left) represents the prompt level used to evoke mands during the treatment exposure assessment (IND = Unprompted; G = Gesture; *p* = Partial; F = Full). The second panel displays the results of the modality choice probes. The third graph (right side) represents the percentage of independent mands using PE across sessions.

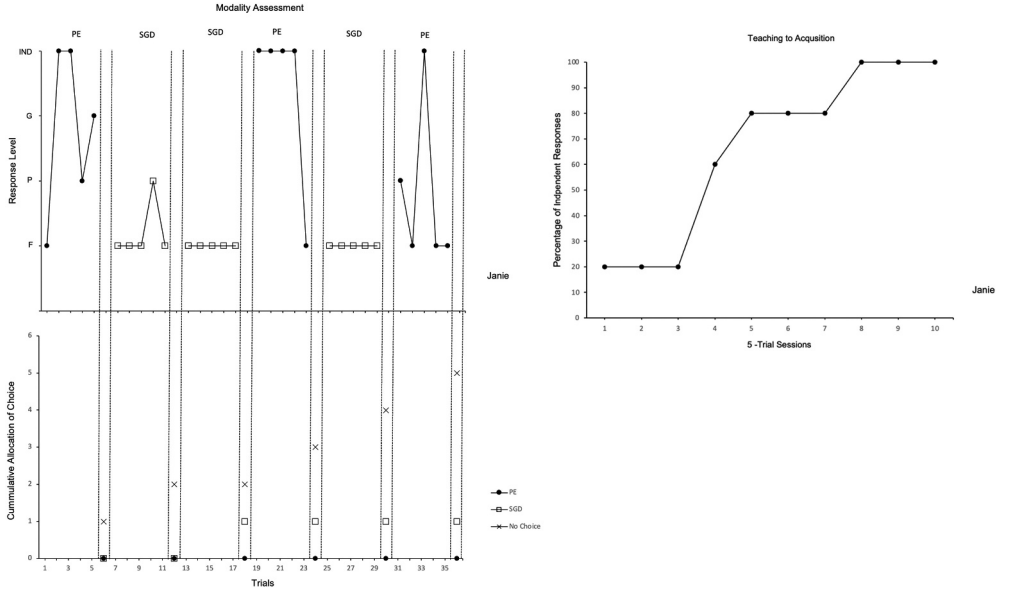

Figure 3. Results for Janie.

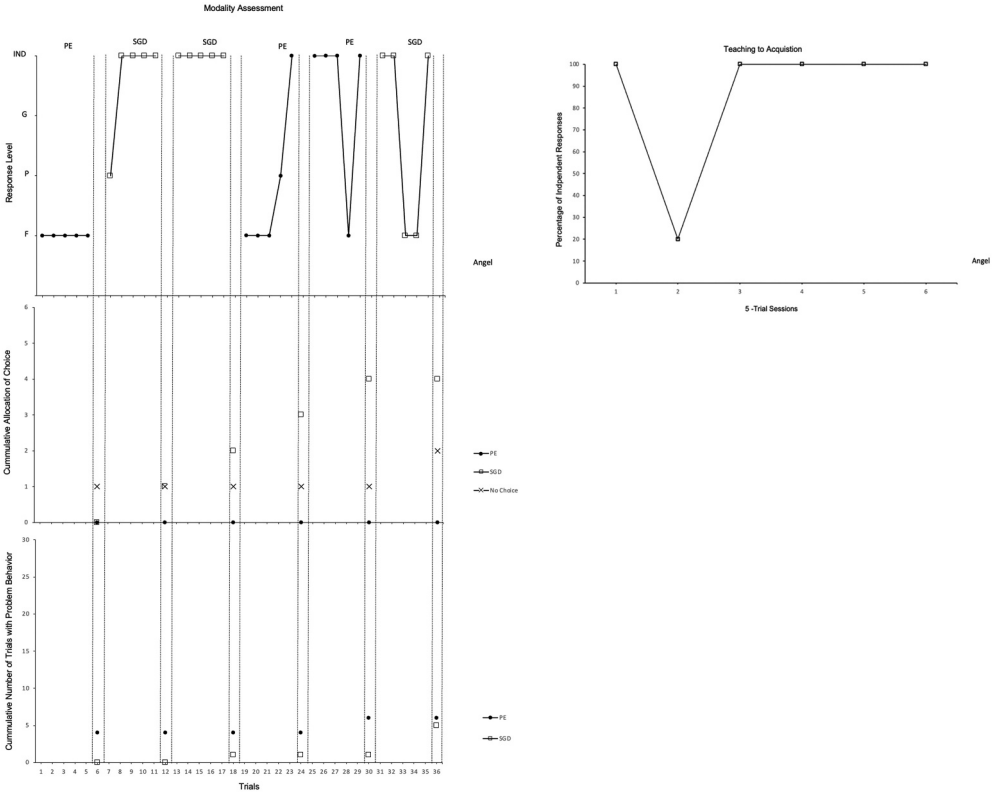

Figure 4. Results for Angel. *Note*. For the first panel, the Y axis (left) represents the prompt level used to evoke mands during the treatment exposure assessment (IND = Unprompted; G = Gesture; *p* = Partial; F = Full). The second panel displays the results of the modality choice probes. The third panel represents the cumulative occurrences of problem behavior during the modality assessment. The fourth graph (right side) represents the percentage of independent mands using an SGD across sessions

prompting during PE sessions (33% independent trials) than SGD sessions (20% independent trials). During the preference probes, she showed the most preference for the PE (67% of choice probes) as compared to the SGD (0% of choice probes). She did not select either modality for 33% of the choice probes (e.g., no choice). Thus, the PE was selected for the teaching to acquisition phase since it had the highest percentage of independent responses in the direct assessment phase and was preferred by Estella. During the teaching phase, independent responding emerged during the second session at 100% accuracy, and acquisition was achieved (i.e., three sessions at 100% independent responding) in 11 sessions.

For Janie (Figure 3), independent responding using PE was observed initially during the direct assessment phase. However, variability in prompts needed for PE trials was observed across the assessment phases. Overall, Janie required less prompting during PE sessions (47% independent trials) than SGD sessions (0% independent trials). A clear preference for either modality did not emerge during the preference probes. Specifically, no choice was made in 83% of the choice probes.

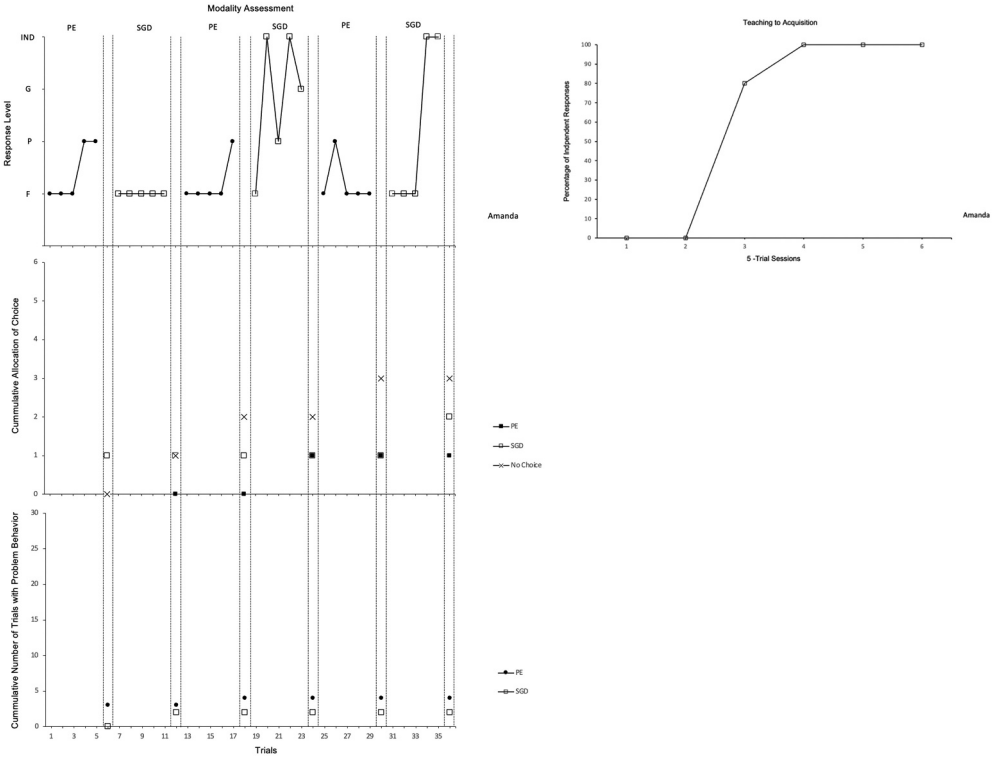

Figure 5. Results for Amanda.

Thus, the PE modality was selected for the teaching phase since it had the highest percentage of independent responses. During the teaching phase, independent responding emerged during the fifth session at 80% accuracy, and acquisition was achieved in 10 sessions.

Figures 4–7 present the results for the children who engaged in comorbid problem behavior. Angel (Figure 4) needed full prompts to respond using PE. Independent responding occurred after ten PE exposure trials (i.e., trial 20). For the SGD responses, independence was observed on the second exposure (e.g., seventh trial) with some variability (i.e., trial 28, 29). Overall, Angel required less prompting during the SGD sessions (80% independent trials) than the PE sessions (33% independent trials). For the preference probes (Figure 6), she showed a preference for the SGD (67%) compared to PE (0%). During the assessment phase, Angel had a slightly lower average of problem behavior during SGD sessions (i.e., 50% average) compared to PE sessions (60% average). Thus, for the teaching phase, the SGD was selected since it had the highest percentage of independent responses during the assessment phase, corresponded with slightly lower occurrences of problem behavior, and was selected the most often during the preference probes (67%) as compared to PE (0%). During the teaching phase, independent responding emerged during the first session at 100% accuracy, and acquisition was achieved (i.e., three sessions at 100% independent responding) in five sessions.

For Amanda (Figure 5), during the direct assessment, initial prompting was needed during PE and SGD sessions. Independent responding was observed first for the SGD

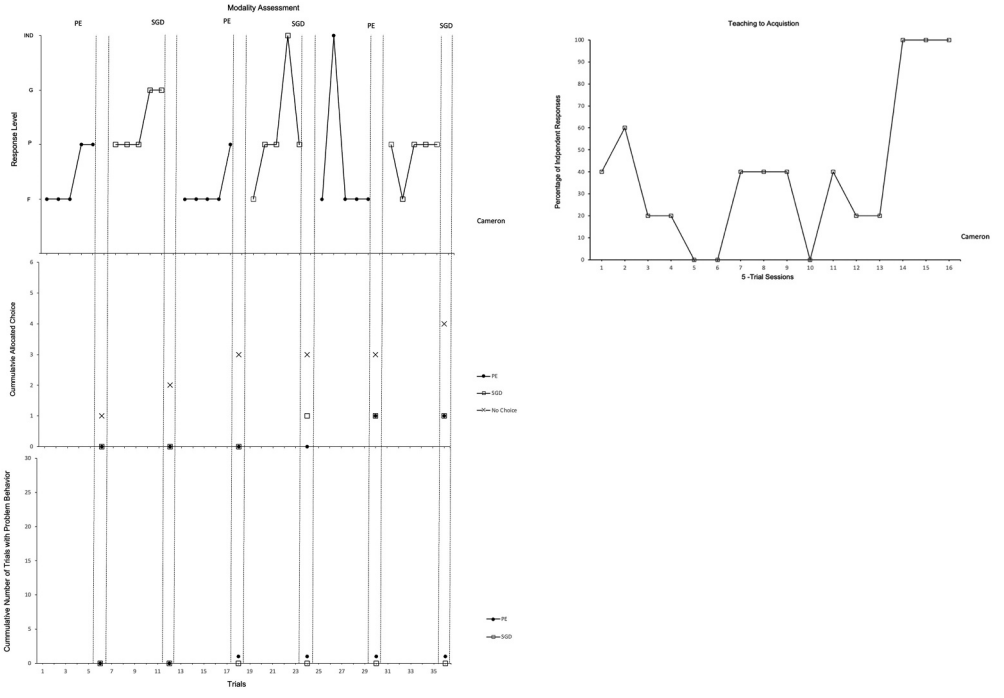

Figure 6. Results for Cameron. *Note*. For the first panel, the Y axis (left) represents the prompt level used to evoke mands during the treatment exposure assessment (IND = Unprompted; G = Gesture; *p* = Partial; F = Full). The second panel displays the results of the modality choice probes. The third panel represents the cumulative occurrences of problem behavior during the modality assessment. The fourth graph (right side) represents the percentage of independent mands using an SGD across sessions

on trials 17 and 19. Overall, Amanda required less prompting during the SGD sessions (27% independent trials) than the PE sessions (0% independent trials). During the assessment phase, Amanda showed a lower average of problem behavior during the SGD sessions (13% average) than in PE sessions (27% average). During the preference probes, she showed the highest preference for the SGD (33%) versus PE (17%). Thus, for the teaching phase, the SGD was selected since it had the highest percentage of independent responses during the assessment phase, corresponded with lower occurrences of problem behavior, and was selected most often during the preference probes. During the teaching phase, independent responding began to occur during the third session at 80% independent responses, and acquisition was reached in six sessions.

For Cameron (Figure 6), prompting was initially needed during PE and SGD sessions. Overall, independent responding was observed only once for each modality. However, less intensive prompting was required for the SGD (13% full prompting) compared to PE (73% full prompting). For problem behavior, Cameron had more instances of problem behavior during PE sessions (7% average) compared to SGD sessions (0% average). During the preference probes, he did not show a preference for either mode in that the SGD and PE were both

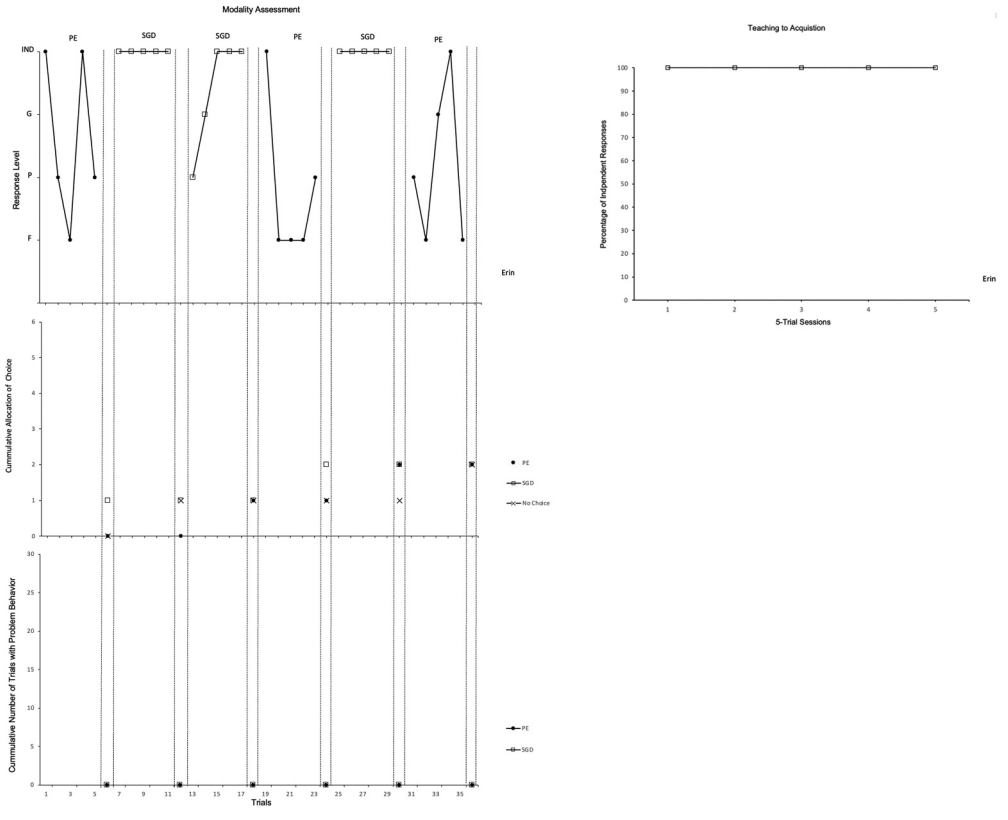

Figure 7. Results for Erin. *Note*. For the first panel, the Y axis (left) represents the prompt level used to evoke mands during the treatment exposure assessment (IND = Unprompted; G = Gesture; *p* = Partial; F = Full). The second panel displays the results of the modality choice probes. The third panel represents the cumulative occurrences of problem behavior during the modality assessment. The fourth graph (right side) represents the percentage of independent mands using an SGD across sessions

selected once (17%). Thus, for the teaching phase, the SGD was selected since it required the least prompting and was associated with a lower occurrence of problem behavior. During the teaching phase, initially, independent responding began to occur during the second session at 60% accuracy, and acquisition was achieved after 16 sessions.

For Erin (Figure 7), variability was observed during PE trials throughout the exposure phase. Independent responses were observed for SGD trials, with two occurrences of prompt trials. Overall, Erin required less prompting during SGD sessions (87% independent trials) than PE sessions (27% independent trials). For problem behavior, Erin had zero instances across both modalities. During the preference probes, a clear preference for either mode did not emerge, and both were selected the same amount (33%) of times. Thus, the SGD was selected for the teaching phase since it had the highest percentage of independent responses and zero occurrences of problem behavior. During the teaching phase, independent responding occurred on the first session at 100%, and acquisition was achieved on the third session.

Total time of modality assessment

The indirect assessment interview with the caregiver took approximately 15 min to complete. The direct modality assessment took an average of 2.5 hours to complete per participant. Specifically, Estella, Janie, and Angel completed the direct modality assessment in 2 hours (i.e., two appointments with three sessions per appointment). Amanda, Cameron, and Erin completed the direct modality assessment in 3 hours (i.e., three appointments with two sessions per appointment).

Acceptability of the modality assessment

Using the TARF-R (Reimers et al., 1992), the social validity rating scale showed the overall acceptability of the modality assessment (see Table 4). The overall mean of reported acceptability on the TARF-R was 4.8. For item two, which measures the perceived acceptability of the treatment, the mean score was 6.5 (out of 7), indicating highly acceptable. For perceived treatment effectiveness (item nine), the mean score was 6.3, which indicates highly acceptable. And for the perceived effectiveness (item 12), the mean score was 6.7, indicating highly acceptable. Lastly, for the degree to which the parents liked the procedures used (item 14), the mean score was 6.3, which indicates highly acceptable.

Table 4. Treatment acceptability rating form – revised (TARF-R) results.

Item	Response
1. How clear is your understanding of the treatment?	6.5 (range, 4–7)
2. How acceptable do you find the treatment to be regarding your concerns about your child?	6.5 (range, 4–7)
3. How willing are you to carry out this treatment?	7 (range, 7)
4. Given your child's communication or behavior problems, how reasonable do you find this treatment?	6.5 (range, 4–7)
5. How costly will it be to carry out this treatment?	1.9 (range, 1–5)
6. To what extent do you think it might be disadvantageous in following the treatment?	1.00 (range, 1)
7. How likely is this treatment to make permeant improvements in your child's behavior?	6.4 (range, 3.5–7)
8. How much time per day will be needed for you to carry out this treatment?	5 (range, 3.5–7)
9. How confident are you that the treatment will be effective?	6.3 (range, 5–7)
10. Compared to other children with behavior difficulties, how serious are your child's problems?	2.9 (range, 1–3.5)
11. How disruptive will it be to your family to carry out this treatment?	1.00 (range, 1)
12. How effective is this treatment likely to be for your child?	6.7 (range, 5–7)
13. How affordable is this treatment for your family?	6 (range, 3.5–7)
14. How much do you like the procedures used in the proposed treatment?	6.3 (range, 5–7)
15. How willing are you to help other family members carry out this treatment?	6.4 (range, 3.5–7)
16. To what extent are undesirable side-effects likely to result from this treatment?	1.6 (range, 1–3.5)
17. How much discomfort is your child likely to experience during the course of treatment?	1.7 (range, 1–3.5)
18. How severe are your child's difficulties?	2.8 (range, 1–5)
19. How willing would you be to change your family routine to carry out this treatment?	7 (range, 7)
20. How well will carrying out this treatment fit into the family routine?	6.1 (range, 3.5–7)

Table 5. Long-term outcomes of the participants.

Participants	Diagnosis	Primary Communication Modality
Estella	Autism Level 2	Vocal
Janie	Autism Level 1	PE
Angel	Autism Level 1	Vocal
Amanda	Autism Level 2	Vocal
Cameron	Autism Level 3	SGD
Erin	Autism Level 2	Vocal

Long-term outcomes

Table 5 includes the long-term outcomes for the participants. At the end of the study, all six participants were diagnosed with autism at the end of the study. Specifically, Janie and Angel were categorized as level 1 severity, Estella, Amanda, and Erin were categorized as level 2 severity, and Cameron was categorized as level 3.

Two years after participation in the present study, researchers followed up with caregivers to identify the primary modality of the participant's communication to evaluate the long-term usage of the selected modality. The caregivers of Estella, Angel, Amanda, and Erin all reported that their children were now engaging in vocal communication and no longer required the use of their AAC mode. Janie and Erin's caregivers reported that their children were still using the PE and SGD that were respectively selected in the assessment.

Discussion

We evaluated an evidence-based multi-phase assessment to evaluate AAC modality options for young children with autism. Specifically, this assessment focused on choice as a foundation element within an indirect assessment with parents to identify suitable modality options, and a direct assessment of two potential modalities with embedded choice probes, followed by a teaching to acquisition phase. The preliminary results indicated a clear AAC option for teaching to acquisition based on the percentage of independent responses achieved and choice selection during the direct assessment phase. For all the participants, the modality selected for the teaching to acquisition phase corresponded with the least prompting needed. For the participants who engaged in problem behavior, the AAC mode selected for the teaching phase also corresponded to low or zero occurrences of problem behavior. These findings align with previous research and highlight the need to consider previous learning history, independence, and learner choice when developing assessment and treatment procedures in the context of FCT (LaRue et al., 2016; Ringdahl et al., 2016). These findings also align with the need to include elements of social validity, such as choice, preference, and individualization (Ferguson & Milne, 2023; Sigafoos et al., 2005) to ensure personalized supports and services provided begin at the assessment level.

There are several findings from this study that warrant discussion. First, although preference across the two modalities only emerged for two of the participants (i.e., Estella and Angel), this process did help ensure that consideration across several important variables (i.e., parent input, learner independence, problem behavior, and learner preference) was incorporated into the assessment process. Consideration across multiple

variables may be especially important when a learner shows some independent responses across the modality options (e.g., Erin). In such cases, careful analysis of the data is needed for decision making.

These findings also indicated the social acceptability of the procedures, outcomes, and time requirements to complete the assessment. Of note, one of the unique aspects of the current study is the relatively short assessment time frame required compared to previous research that has used similar comparative methods (Kunnavatana et al., 2018; van der Meer et al., 2012). This may aid in the feasibility of using a multi-phase assessment in applied settings where resources are limited. Also notable, these findings support the notion that early AAC interventions do not hinder the development of spoken communication (Gevarter & Horan, 2019) but might further support continued communication development for children with autism. Considering these preliminary findings, future research is needed to expand the evaluation and application of this assessment model across participant types, modality options, and evaluation of the effects across time.

When a child has not yet developed spoken communication, there is no clear superior type of alternative modality since each modality has potential benefits and disadvantages, many of which may be specific to an individual's needs and the environment. The findings of this study extend previous literature that compared the acquisition of AAC modalities and evaluated individual preference (McLay et al., 2015; Valentino et al., 2019; van der Meer et al., 2012) and highlight the value of individualized assessment and data-based decision-making when evaluating possible AAC options. Further, the current study highlights the use of an experimental analysis framework (i.e., indirect assessment of potential modalities followed by direct assessment) to evaluate these variables. Specifically, the indirect assessment was a useful first step to ensure listeners in the natural environment support a modality option, prior learner history, and prerequisite skills are discussed as AAC options are considered. Additionally, the direct assessment effectively facilitated data-based decision-making when selecting a modality for teaching to an acquisition level.

One important aspect of this research is the value of including multiple components of social validity, as defined by Wolfe (1978). This assessment framework provided three key aspects of social validity: 1) socially acceptable goals, 2) socially acceptable procedures, and 3) wanted outcomes for both the individual and families. Specifically, consultation with the family, who uniquely understands the learner's needs and will likely engage as listeners to help establish communication repertoires, was included to identify which modalities were associated with potential benefits and potential counter-therapeutic risks (e.g., association to problem behavior, barriers of use; Hanley, 2010). Direct assessment of the individual's responses and direct assessment of the individual's choice were also included as components of social validity (Hanley, 2010).

Another implication of these findings is that this assessment process may benefit learners with limited and underdeveloped repertories. In the present study, these participants had very limited functional communication repertoires, and the assessment and teaching to acquisition phases were conducted in the context of mands. This context aligns with the recommendations from previous research on establishing initial communication for children learning to use AAC systems (Carnett et al., 2021; Ganz, 2015). As

such, the learner's motivation for a mand was accounted for by evaluating preference before the session, and for participants with problem behavior, this was identified through the FA results. Thus, this study affirms that assessing in the context of mands may be optimal for establishing an AAC modality, rather than other operants, which are reinforced by socially conditioned reinforcement (e.g., comments for the communication partner, social praise).

Considerations for application

Although these positive outcomes support a systematic approach for making assessment-based decisions for young children who are candidates for AAC systems, these findings are preliminary. Thus, the following considerations should be made for application. There is likely a need for continued assessment of modality choice, preference, and functionality. For example, some children may show better initial acquisition of picture/symbolic exchange-based systems rather than the use of touchscreen-based SGDs. However, as children mature and learn to use technology, touchscreen-based SGD might be more conducive and socially appropriate (Achmadi et al., 2015; Broadhead et al., 2020). Longitudinal evaluation of choice, preference, and functionality should be considered for future research since preference will likely vary across acquisition and maintenance. Further, this research highlights the importance of access to early AAC interventions to support communication needs (Drager et al., 2010). As seen in four of the current participants, vocal speech was reported to emerge later, and the use of the AAC system was no longer required. It is unclear what effect, if any, this early communication intervention may have had on supporting speech development. Thus, longitudinal evaluation would be beneficial to better understand the long-term effects of early communication interventions and under what conditions vocal speech development may occur (White et al., 2021).

Limitations

The current study is limited in that this model of assessment is preliminary and may warrant extension. Specifically, given that most of the participants' data indicated preference did not emerge, extended and ongoing assessment may be useful to evaluate modality proficiency and preference implications. Additionally, the children included in the present were all at risk for autism. However, many children with a variety of disabilities and CCN may benefit from this type of assessment process. Thus, future research should replicate these procedures with other populations. The participants included in this study they were also quite young, so naturalistic five-trial block sessions were selected to account for the developmental needs. However, for older individuals, adaptations to these procedures may be needed. For example, measurement of repeated phases to compare AAC options, and analysis of AAC use over time may be warranted, especially as an individual progresses in the development of their communication skills. Thus, we encourage considerations of the specific needs of the individual to inform adaptations (e.g., assessment length, number of trial presentations, and other environmental variables) and continued

assessment over time. Lastly, we considered the application of this framework across children learning initial mands for tangible items and in the context of FCT, which included targeting functionally equivalent mands (i.e., attention, tangibles, and escape) based on FA data. Although conceptually all participants were learning basic mands, variation of function across participants adds complexity when comparing outcomes, thus replication and extended analysis across function may be warranted.

Conclusion

In summary, these results highlight the need for careful assessment and planning before the start of an AAC intervention, especially for those being supported in the context of problem behavior. Specifically, this study highlights the importance of an EBP-based assessment model focusing on a foundation of choice within the assessment context. It further highlights the usefulness of an approach that incorporates aspects of social validity within the initial AAC assessment.

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Appendix

Compliance with Ethical Standards

The authors report no conflicts of interests and are solely responsible for the content and writing of this paper. All data generated and analyzed during this study are included in this published article. 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 from all individual participants involved in the study. The researchers gained approval for this study from the University of Texas at San Antonio Institutional Review Board.

Date:_____ Child/Client:_____

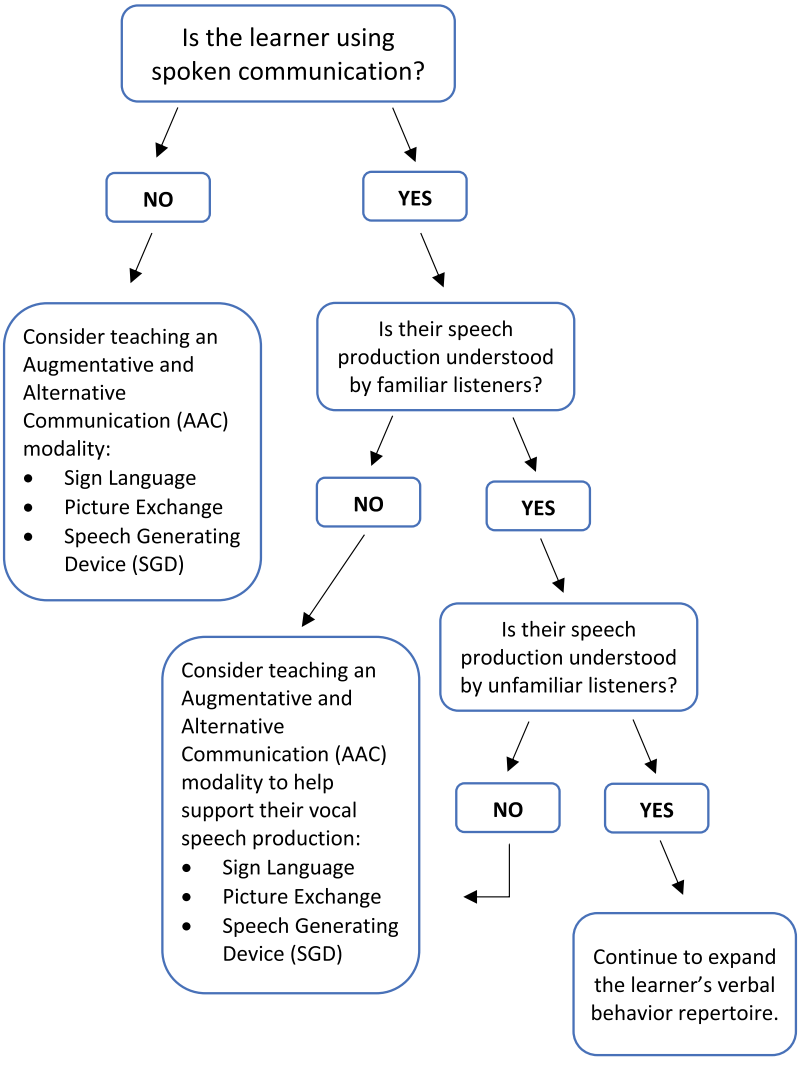
Interviewer:_____ Respondent:_____

Relation to the child: _____

Directions: Use the flow chart below to guide a conversation about possible modalities and their considerations for use.

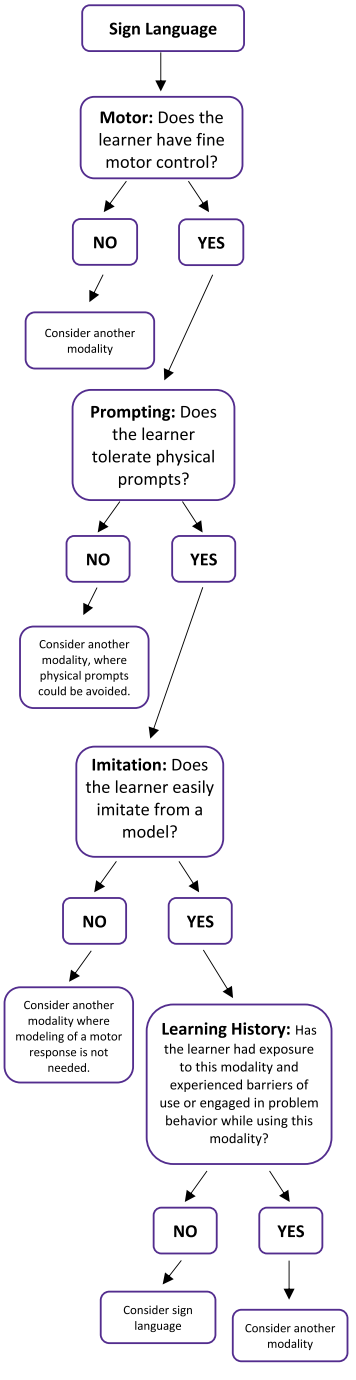
For each modality, be sure to discuss the considerations listed and discuss any concerns the caregiver may have.

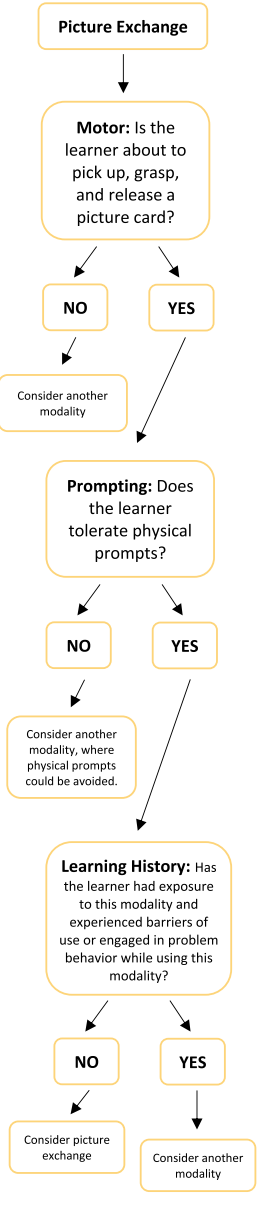
Be sure to discuss any prior experiences the child may have with any of these modalities, especially in the context of problem behavior.

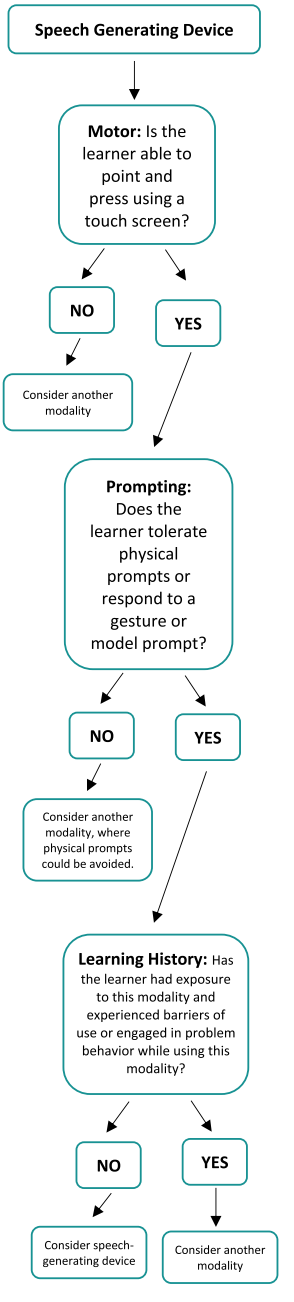


Considerations for spoken communication:

- Is the learner able to adequately articulate words that can be understood by a variety of listeners?
  - If yes, then continue to develop the spoken verbal behavior repertoire.
  - Be sure to assess the formal properties of speech production using a direct assessment (e.g., VB-MAPP)
  - If no, consider supplementing with an AAC modality so that the spoken communication can be supported.
  - If the child engages in problem behavior related to spoken communication, consider an AAC modality for FCT.







3

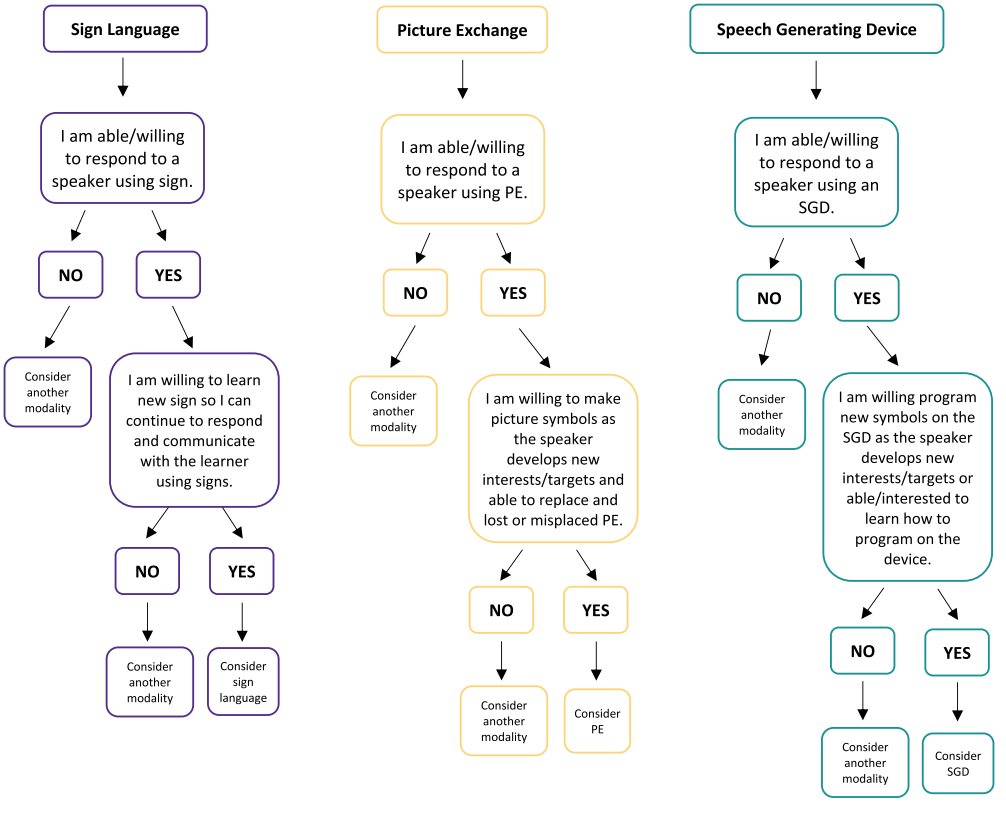
Considerations for spoken communication

- **Learner Preference**
  - Teaching exposure for each modality being considered has been provided.
  - Choice probes for each modality being considered have been provided.

- If the AAC modality is associated with problem behavior, consider using a different modality that is not associated with the problem behavior for FCT.

- **Cost**
  - Picture Exchange – I am able to purchase a laminator, Velcro, and have access to a computer, printer, and ink to make PEs.
  - Speech-Generating Device – I am able to purchase a touch screen device and speech-generating application and protective case.
- **Time**
  - Picture Exchange – I am able to spend time making PEs and replacing them when they are misplaced or lost.
  - Speech-Generating Device – I am able to program or willing to learn how to program the device.

Decision-Making Model for Listeners



Other Listener Considerations:

- Familiar listeners will be able to respond to the selected modality?
  - If yes, then continue the selection/use of the modality.
  - If no, consider other modality options.
- Peers will be able to respond as listeners to the selected modality?
  - If yes, then continue the selection/use of the modality.
  - If no, consider other modality options.

- Unfamiliar listeners within the community will be able to respond as listeners to the selected modality?
  - If yes, then continue the selection/use of the modality.
  - If no, consider other modality options.