Behavioral Interventions

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RESEARCH ARTICLE

The Effects of English and Spanish Instructional Sequences on the Acquisition of Conditional Discriminations

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ABSTRACT

There is limited behavior analytic research evaluating the impact of teaching in both the familial and culturally dominant languages in bilingual children with autism. The purpose of this study was to examine the effects of instructional sequences and language preference on the rate of acquisition of a receptive identification task targeting English and Spanish nouns with three Spanish-English bilingual children with autism. An adapted alternating treatments design was employed to compare three instructional sequences: (1) English-Spanish, (2) Spanish-English, and (3) mixed. Results for one participant demonstrated the mixed language training sequence to be the most efficient training sequence, while the Spanish-English sequence was most efficient for the other two participants. Language preference did not appear to impact learning. The results of this study are discussed in terms of the Naming Theory (Horne and Lowe 1996), and providing culturally responsive care to bilingual learners with autism.

1 | The Effects of English and Spanish Instructional Sequences on the Acquisition of Conditional Discriminations

Latinx people account for more than half of the population growth in the US between 2010 and 2022 (Pew Research Center september 12, 2024). They have become the largest racial/ethnic group in California (2014) and Texas (2021) (Pew Research Center september 12, 2024). The prevalence of children diagnosed with autism spectrum disorder (ASD) has also been steadily increasing with prevalence among Asian, Black, and Hispanic children at least 30% higher in 2020 compared to 2018 (Centers for Disease Control 2023, march 22). Communication impairment and delays are a defining characteristic of ASD (American Psychiatric Association 2000), which makes selecting the social and instructional language a unique concern for caregivers and practitioners of bilingual children with ASD. Kay-Raining Bird and colleagues (2012) reported that almost half (43%) of their survey respondents, which consisted of caregivers from the United States and five other countries, have been advised not to raise their child with ASD bilingually. Unfortunately, it is a common recommendation to teach children with ASD only one language despite a lack of empirical support for this recommendation (Valicenti-McDermott et al. 2013). Due to the growing bilingual, specifically Spanish speaking, population of children with ASD and an increased consciousness within the field of Behavior Analysis to provide culturally responsive and ethical care, it behooves us as researchers to carefully examine the effects of targeting both languages in bilingual children with ASD.

There are multiple benefits to speaking more than one language fluently including improved problem solving, perspective taking, and academic skills as compared to their monolingual counterparts (Pransika 2017). It is important for individuals from bilingual homes to speak in both the culturally dominant language and in their familial language. While the benefits of speaking the culturally dominant language are evident (social, educational, and vocational success, and safety), the benefits of speaking in the familial language by some professionals is overlooked. Some benefits of speaking the familial language include increased contact with reinforcers for the family and the consumer, participation of the consumer in cultural and familial events, and the family and consumer may be better able to meet one another's needs. Sometimes, it may be appropriate to select one language to teach some subsets of targets, but in many cases teaching in both languages is indicated, and we need to establish the most effective and efficient procedures to accomplish this.

There is a dearth of behavior analytic research on language acquisition in bilingual children with language delays and ASD. However, there is growing evidence that not only is there is no negative impact of multilingual exposure for these children (Ohashi et al. 2012), but also there is evidence of positive social and language development effects (Drysdale et al. 2015; Zhou et al. 2019). Banerjee et al. (2022) demonstrated the effectiveness of teaching functional communication responding in both Spanish and English to two children with ASD from Spanish-speaking households. When only taught the functional communication response in one language, the response was met with extinction in contexts in which it was not spoken, and problem behavior resurged. After the functional communication response was taught in both Spanish and English, the participants contacted high rates of reinforcement in both language contexts and problem behavior rarely occurred. Enriquez et al. (2023) published a case study evaluating a verbal operant experimental analysis which allows bilingual speakers to switch freely between languages during the verbal behavior assessment. This technology can assist practitioners and researchers in providing a more technically, functionally, and culturally sensitive and accurate verbal behavior assessment, contributing to better treatment development and outcomes, and greater community and cultural acceptability.

Best practices in behavior analysis include preference assessments to determine effective reinforcers, materials, and other items to support and enhance treatment (Hagopian et al. 2004). Some important components of an effective individualized intervention plan include identifying skills to teach, schedules of reinforcement, and treatment strategies, just to name a few. The language spoken by the therapist is a component of programming that is often overlooked when working with bilingual individuals. Aguilar et al. (2016) evaluated language preference of instruction for students with developmental disabilities (DD) and found that learners had a clear language preference when completing more difficult tasks when compared to completing easier ones. In this study, the participants were four bilingual children from predominantly Spanish-speaking homes, diagnosed with ASD or another DD. Target skills were determined for each participant that ranged from "easy" (mastered skills in the participants' repertoire) to "difficult" (novel skills). The results of this study suggest that as task difficulty increased, the preferred instructional language was allocated almost completely to one specific language. This suggests language preference could possibly have an impact on rate of skill acquisition for new, "difficult," skills. Previous studies have also assessed client preference with order of instructional tasks (Dyer et al. 1990), treatment type (Hanley et al. 1997), and preference for and corresponding reinforcer efficacy of the language of praise delivered to bilingual children with ASD (Clay et al. 2020). Evaluating and when applicable, incorporating preferred components in treatment programs can result in decreases in challenging behavior, increases in motivation, and overall improved treatment effects.

Outside of behavior analysis, there have been a few studies evaluating instructional sequences and their effects on language acquisition in bilingual children with developmental disabilities. Perozzi and Sanchez (1992) examined rates of sequenced multilingual acquisition of prepositions and pronouns for children with speech delay from Spanish-speaking homes. The study included two groups: one group received instruction in Spanish followed by instruction in English, and the second group received instruction in English, only. The task consisted of receptive identification of the targets in both languages in the corresponding instructional language trials (i.e., Spanish targets in the Spanish trials and English targets in the English trials). The results indicated that the children who received both Spanish and English instruction learned the English targets twice as quickly compared to the English-only group. Gutierrez-Clellen et al. (2012) conducted a study evaluating "cross-linguistic interdependence," which proposes that there is a transfer of language skills when the languages are presented or spoken in close temporal proximity. Their results demonstrated that Spanish-English bilingual children showed a greater increase in English language skills when both English and Spanish were targeted simultaneously during the intervention. Both studies were conducted with children with documented speech and language delays, but not with children with ASD.

There is a need for behavior analytic research on language acquisition in bilingual children, specifically children with ASD, and the optimal instructional sequencing for skill acquisition in both languages. Therefore, the purpose of this study was to evaluate the effects of instructional sequences and language preference on the rate of acquisition of a receptive identification task of English and Spanish nouns in Spanish-English bilingual children with ASD. The results of this study contribute to language acquisition in bilingual children with ASD and to bilingual research in behavior analysis, in general.

2 | Method

2.1 | Participants and Setting

The participants were three children diagnosed with ASD. Gabby was a 6-year-old girl, Adrian was an 8-year-old boy, and Armando was a 6-year-old boy. All participants were referred to the study by a graduate student therapist at a clinic where they were receiving applied behavior analysis (ABA) services. Inclusionary criteria for participation in the study required the

children to have an ASD diagnosis, comparable proficiency level in both English and Spanish languages, consistent exposure to both languages in the home and/or school, and minimal problem behavior.

All assessments and treatment sessions were conducted by the same graduate-level therapist (per participant) who was fluent in both English and Spanish and had experience working with children with ASD using ABA techniques. Exposing each participant to only one therapist was done to control for bias for or against a particular therapist instead of the specified language. All assessments and training sessions for Gabby and Adrian were conducted in a treatment room at an ABA clinic, which contained one rectangular table, two chairs, and shelves with materials necessary for training sessions. All assessment and training sessions for Armando were conducted in a treatment room at a university-based clinic which contained two tables, two chairs, and materials necessary for training sessions.

2.2 | Materials

Instructional stimulus sets consisted of pictures of objects identified as unknown to the participant. Each set consisted of three stimuli used for training in both English and Spanish language conditions, meaning each stimulus was a training target in both languages. The instructional stimuli cards used during training sessions were 3 in. × 5 in. Index cards with colored pictures on a plain, white background. The stimuli sets were equated across conditions to be of similar difficulty by organizing the targets in each condition to have a similar (i.e. ± 2) total syllable count. This was achieved by counting the number of syllables per word in both languages and adding the syllable counts for all stimuli in each condition. Stimuli were excluded if the words were too similar in both languages (e.g., car and carro). Tables 1 to 3 display stimulus sets with the total syllable counts for Gabby, Adrian, and Armando, respectively.

2.3 | Data Collection

2.3.1 | Dependent Variable and Measurement

The primary dependent variable was the total number of training trials to the mastery criterion for card selection in both English and Spanish for each stimulus set. A paper-and-pencil method was used to score correct and incorrect responses during each trial. A correct response was scored if the participant independently pointed to the correct card within 5 s of the instruction. An incorrect response was scored if: (a) the participant did not point to a card within 5 s, (b) pointed to the incorrect card, or (c) pointed to the correct card without looking. The percentage of correct responding per session was calculated by dividing the number of correct responses by the total number of trials in the session. The mastery criterion for training was 11/12 (92%) independent responses across three consecutive 12-trial blocks. Once responding met the mastery criterion for the training sets, the total number of training trials required to meet the mastery criterion for both English and Spanish for each set was graphed.

2.4 | Interobserver Agreement

For each participant, the therapist served as the primary data collector for 100% of the sessions. A secondary observer

TABLE 1 | Stimulus sets by training sequence for gabby.

English–Spanish		Spanish–English		Mixed	
Set 2		Set 1		Set 3	
Plum	Ciruela	Compass	Brujula	Barber	Peluquero
Eggplant	Berenjena	Wallet	Cartera	Referee	Arbito
Beet	Betabel	Coaster	Posavasos	Waiter	Mesero
Set 4		Set 5		Set 6	
Jellyfish	Medusas	Pomegranate	Granada	Lettuce	Lechuga
Walrus	Morsa	Peach	Durazno	Spinach	Espinaca
Shrimp	Camaron	Grapefruit	Toronja	Cabbage	Repollo
Set 9		Set 7		Set 8	
Drill	Taladro	Dresser	Vestidor	Carnation	Clavel
Dumbbell	Pesa	Armoire	Gabinete	Clover	Trebol
Pliers	Pinsas	Stove	Estufa	Lily	Azucena
Set 10		Set 12		Set 11	
Sunflower	Girasol	Clams	Almejas	Chickpea	Garbanzo
Daffodil	Narciso	Lentils	Lentejas	fig	Higo
Poppy	Amapola	Cinnamon	Canela	Garlic	Ajo
Total syllable count: 59		Total syllable count: 62		Total syllable count: 60	

Note: English–Spanish Spanish-English mixed.

TABLE 2 | Stimulus sets by training sequence for adrian.

English-Spanish		Spanish-English		Mixed	
Set 1		Set 3		Set 2	
Heel	Talon	Soldier	Soldado	Peach	Duranzo
Ankle	Tobillo	Lifeguard	Salvavidas	Butter	Mantequilla
Knee	Rodilla	Barber	Peluquero	Oil	Aceite
Set 6		Set 5		Set 4	
Walrus	Morsa	Arrow	Fleche	Stove	Estufa
Ostrich	Avestruz	Diamond	Diamante	Blender	Licuadora
Seal	Foca	Cross	Cruz	Whisk	Batidor
Set 9		Set 8		Set 7	
Lettuce	Lechuga	Mop	Trapeador	Coat	Abrigo
Olive	Aceituna	Jar	Frasco	Vest	Chaleco
Pomegranate	Granada	Hose	Manguera	Magnet	Iman
Total syllable count: 41		Total syllable count: 39		Total syllable count: 40	

Note: English–Spanish Spanish–English mixed.

TABLE 3 | Stimulus sets by training sequence for Armando.

English–Spanish		Spanish–English		Mixed	
Set 1		Set 2		Set 3	
Coal	Carbon	Foundation	Base	Elbow pads	Codederas
Pitcher	Jarro	Referee	Ginger	Jenjibre	Cedazo
Dill	Eneldo	Liver	Igado	Birch	Abedul
Set 6		Set 4		Set 5	
Slate	Pizarra	Eyeshadow	Sombra	Shoulder pads	Hombreras
Chamomile	Cesta de fritura	Decanter	Licorera	Turmeric	Curcuma
Fry Basket	Manzanilla	Kidneys	Riñones	Maple	Abedul
Set 9		Set 8		Set 7	
Jet	Azabache	Carafe	Botellon	Fennel	Hinojo
Sage	Salvia	Highlighter	Illuminador	Knee pads	Rodilleras
Skimmer	Espumadera	Spleen	Bazo	Oak	Roble
Total syllable count: 48		Total syllable count: 47		Total syllable count: 46	

Note: English–Spanish Spanish-English mixed.

independently collected data on each of the responses during training trials for at least 30% of the total training trials per participant; these data were collected from video recordings of the training sessions. The primary and secondary observers' data were compared on a trial-by-trial basis. Interobserver agreement was calculated by taking the number of trials with exact agreement in a session and divide them by the total number of trials completed in the session, and then multiped by 100 to convert to a percentage. An agreement was recorded if both observers record the same response on a specific trial (e.g., correct or incorrect response). A disagreement was scored if the observers recorded different responses for a trial. IOA was collected for 34% of all the sessions for Gabby (M = 99%; range 92%–100%), 31% of the sessions for Adrian (M = 98%; range 67%–100%), and 33% for Armando (M = 97.7%; range 75%–100%).

2.5 | Procedural Integrity

Procedural integrity data were also collected by a secondary observer. For each trial, the observer scored therapist responses for: (a) correct presentation of the instructional stimuli and instruction in designated language, (b) correct implementation of the error correction and prompting procedures, and (c) correct reinforcer delivery (e.g., edible and praise in designated language). The observer scored the implementation of each component per trial as correct or incorrect. The percentage of correct implementation was calculated by dividing the number of components that were correctly implemented by the total number of available components per trial and multiplying it by 100 to obtain a percentage. Treatment integrity was assessed for 34% of the sessions for Gabby (M = 99%; range 92%–100%), 31%

of the sessions for Adrian ($M = 99\%$; range 96%–100%), and 31% for Armando ($M = 94\%$; range 73%–100%).

2.6 | Social Validity

2.6.1 | Caregiver Interview and Questionnaire

Parents of the participants were asked to complete a questionnaire focused on language usage and personal experiences related to bilingualism with their child. Questions were aimed to determine the participants' current language usage in various environments, perceived language preference and fluency, and previous recommendations received for language usage with their child. The questionnaire consisted of open-ended and rating scale questions on a 1-5 Likert scale.

Gabby's mother completed the questionnaire and mentioned during the interview that it was previously recommended to her to only speak in English to Gabby because multilingual exposure "may confuse her" and delay her language development. Adrian's mother completed the questionnaire and stated that although it was never recommended to her to no longer use the familial language with her child, she was told that he learns better in English. Both parents had high ratings regarding the importance of their child learning both languages and their interest in more information and guidance on this topic. Ratings varied regarding their child's perceived fluency level and language preference. Due to experimenter error, the questionnaire was not administered to Armando's caregiver.

2.7 | Pre-Experimental Procedures

2.7.1 | Assessing Language Fluency

The participants language proficiency in English and Spanish was compared by conducting the listener responding section of the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg 2008) in both languages. The purpose of this procedure was to assess the participants' fluency in both languages before the study to confirm the participants' skills were not drastically superior in one language over the other.

Gabby demonstrated skills in Levels 1, 2, and 3 of the listener responding section of the VB-MAPP when conducted in both English and Spanish. She was able to select correct items from an array, perform motor actions and follow one-component instructions, and generalize listener discriminations in both languages. There were gaps in both languages in Level 3, particularly regarding following two-component word instructions and 3-step directions. Adrian also demonstrated skills in Levels 1, 2, and 3 of the assessment. He was able to select correct items out of an array, perform simple motor actions, and generalize listener discriminations in both languages. Adrian had gaps in Levels 2 and 3 in both languages. Armando demonstrated skills in Levels 1, 2, and 3 of the assessment. He was able to select correct items from an array, perform simple motor actions, follow one-component instructions, and generalize listener discriminations in both languages. Anecdotally, Armando initiated conversation more frequently in Spanish at the beginning of experimental procedures, even when the therapist responded in English. For the purposes of this study, all participants' language proficiency was similar regarding necessary skills to complete the requirements and training of this study.

2.7.2 | Stimulus Preference Assessment

A brief multiple stimulus without replacement preference assessment (DeLeon and Iwata 1996) was conducted with each participant to determine toys or edible items to utilize as reinforcers during training sessions. The highest preferred item identified was then utilized for the entire session, unless the participant requested another item, which did occur with all participants. Because all participants' preferences changed frequently within session, the therapist began presenting five to six preferred items for the participant to choose from during training trial-blocks. Gabby always chose to work for edibles, Adrian chose to work for the tablet, video game console, or edibles, and Armando chose to work for a phone, iPod, or a play kitchen set.

2.7.3 | Language Preference Assessment

The purpose of the language preference assessment was to determine the participant's preferred language prior to introducing the training trials. One bilingual therapist conducted all the preference assessment trials in both languages. Initially, the language preference assessment was conducted in two separate rooms: one room was designated for English play and the other for Spanish play. The use of multiple rooms was only utilized for one assessment day for Adrian, and the change to the single-room procedure was implemented the second assessment day and continued for the remainder of the sessions and other participants. The assessment was conducted in a room which contained three identical tables and chairs; each table was placed along one wall in the room. One table was designated as the English table, another the Spanish table, and the third served as the control. The two language tables consisted of the exact same materials, toys, and items; the control table was empty. During the assessment, the only difference between the three tables was the language associated and spoken; in the case of the control table, no language was spoken. The preference assessment consisted of exposure trials and paired-choice test trials. Each trial, both exposure and choice, was 5 min in length. A timer was used to ensure the participant and therapist were aware of the time per trial; the therapist also had a vibrating timer on their person to ensure a comment in the designated language was made at least every 30 s. This was done to ensure the participant was exposed to the designated language for a similar duration of time per table. If the participant engaged in conversation with the therapist prior to or after the 30 s timer, the therapist also responded.

Exposure trials were conducted prior to the choice test trials to ensure the participant was exposed to both language conditions

and experienced the difference in contingencies of all tables. Two sets of exposure trials were conducted prior to the choice test trials. Exposure trials consisted of the therapist physically guiding the participant to each table and engaging in play in the designated language. The procedure was the same for the English and Spanish tables, aside from the language spoken. For the exposure trials at the control table, the participant was physically guided to sit at the table and no comments or attention were provided (i.e., no language was used). After the exposure trials, the therapist physically guided the participant to stand along the empty side of the session room, facing all the tables, and said "Pick a table: play in English; Escoje uno: jugar en Español?" while pointing to each table as the language is specified. The presentation of the language options was alternated to ensure the same option was not presented first or second every time. An approach was recorded when the participant sat down in a chair at one of the tables. The choice trial procedures were identical to the exposure trials, except the participant was not physically prompted and was allowed to choose among the tables. Choice trials were conducted until a clear preference was identified (i.e., seven consecutive sessions of the same language chosen). Exposure trials were conducted at the beginning of each assessment day if there is a break between sessions (i.e., if the assessment was not completed in one day, the next assessment day would begin with exposure trials before choice trials). The language preference assessment for Armando was discontinued after 15 trials in which a preference for a specific language was not identified.

2.7.4 | Probes to Identify Targets

Probes to identify targets were conducted to confirm the stimuli used for the instructional training sets were unknown to the participant. Stimuli were presented in an array of three. For English targets, the three stimuli were presented in a straight line on the table in front of the participant, the instruction "Touch the ___" was provided, and the participant was given 5 s to respond. For Spanish targets, the procedure was identical to the English, except the instruction "Toca el/la ___" was provided. No programmed consequences were provided for correct or incorrect responding. Each stimulus was presented three times for each language in a random order so that the same target was not presented twice in a row, and the order of language presentation was counterbalanced (i.e., for the first set, the English word is presented first, for the second set, Spanish is presented first, and e.t.c.). English word probes and Spanish word probes were conducted separately, in their assigned training sets. The target stimuli picture cards were rotated so that one card was not placed in the same location for more than two consecutive trials. Stimuli were included in the training sets if accuracy was 33% or lower during the probe trials.

2.8 | Experimental Design

An adapted alternating treatment design (Sindelar et al. 1985) was employed to compare three instructional sequences: (1) English-Spanish, (2) Spanish-English, and (3) mixed language (Spanish and English). The sequences were counterbalanced across stimuli sets and the order of conditions was randomized across participants.

2.9 | Experimental Procedures

Participants were trained to receptively identify the targets in one stimulus set at a time until reaching the mastery criterion in both languages following the assigned sequence. A trial block consisted of 12 trials during which each target stimulus was presented 4 times. In the English-Spanish and Spanish-English sequences, each target was trained in one language first before training was conducted in the other language (e.g., in the Spanish-English sequence, targets were trained to mastery in Spanish first, and then trained in English to mastery second). Therefore, the 12 trials consisted of four presentations each of the three stimuli in the set. In the mixed language sequence, each stimulus was presented two times in English and two times in Spanish during one 12-trial block. The mastery criterion was 11/12 (92%) correct independent responses across three consecutive trials blocks.

2.9.1 | English Training

During the English training sessions, a set of three stimuli was placed on the table in front of the participant. The instruction was presented in English (e.g., "Point to the ___") and the participant was allowed 5 s to respond. If a correct response was emitted (i.e., the participant pointed to the correct picture within 5 s of the instruction), the therapist provided enthusiastic, descriptive praise and a preferred item or edible. If an incorrect response was emitted (i.e., the participant pointed to the incorrect card, did not look at the card to which they are pointing, or did not respond within 5 s), a least-to-most prompting sequence was utilized to ensure a correct response. The prompting sequence included a gestural prompt and a physical prompt. After the first incorrect response, the experimenter told the participant, "Hands down" and modeled, if necessary, for the participant to place their hands in a neutral position on the table. The experimenter then reissued the instruction while immediately providing a gestural prompt by pointing to the correct card. If the participant responded incorrectly following the gestural prompt, the experimenter reissued the instruction and immediately provided a physical prompt by guiding the participant's hand to point to the correct picture. A correct prompted response (e.g., correct response following a gestural or physical prompt) resulted in descriptive praise in a neutral tone of voice. Physical prompts were not required for any of the participants during training.

2.9.2 | Spanish Training

These trials were procedurally identical to the English training trials except the auditory stimulus, experimenter praise, and vocal prompts were presented in Spanish.

2.9.3 | English-Spanish Training Sequence

The designated set of three target stimuli were trained first in English to the mastery criterion, followed by training in Spanish to the mastery criterion.

2.9.4 | Spanish-English Training Sequence

The designated set of three target stimuli were trained first in Spanish to the mastery criterion, followed by training in English to the mastery criterion.

2.9.5 | Mixed-Language Training Sequence

Training consisted of teaching each target in English and Spanish simultaneously until responding in both languages reached the mastery criterion. Alternation between languages occurred on a trial-by-trial basis. For example, if the stimuli in one training set consisted of apple/manzana, banana/platano, and orange/naranja, and English will be trained first, the languages will be alternated so that not one language is presented more than two times consecutively. In this example set, the presentation could be: Apple, Platano, Naranja, Banana, Manzana, Orange, Banana, Platano, Manzana, Orange, Apple, Naranja. The two languages continued to be alternated in this way with all the words in the set until the mastery criterion was reached in both languages, for all of the targets. For some sets, mixed language sequence training started in English and for others it started with training in Spanish, and this was counterbalanced across sets.

3 | Results

For the language preference assessments, data were collected on the cumulative number of selection responses during the choice trials. The results of the language preference assessments showed both Gabby and Adrian's preferred language was English, and Armando's assessment did not show a preference for either language. The choice trials continued until a clear preference was determined (i.e., seven consecutive selections of the same language) for Gabby and Adrian. Gabby selected English a total of 16 times, Spanish 6 times, and the control 0 times. Adrian selected English 10 times, Spanish 3 times, and the control 0 times. Once the procedures were modified and choice trials were conducted in the same room, Adrian only selected the English table. This suggests that this procedural modification was effective in altering the MO to switch rooms. Armando selected English a total of 6 times, Spanish a total of 9 times, and the control 0 times.

Figures 1, 2, and 3 display the data from the comparison of the three language instructional sequences to teach unknown English and Spanish nouns for Gabby, Adrian, and Armando, respectively. For all three participants, the greatest differences in terms of the total number of training trials to meet the mastery criterion across the instructional sequences was observed in the first sequence of training sets. As training

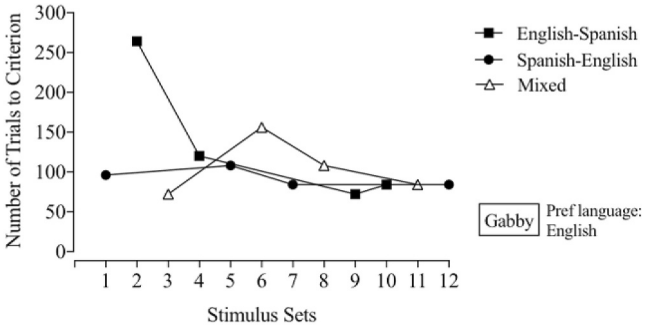

FIGURE 1 | Trials to the mastery criterion across instructional sequences for Gabby.

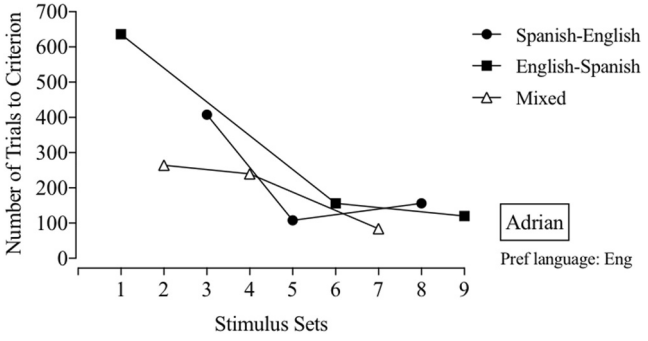

FIGURE 2 | Trials to the mastery criterion across instructional sequences for Adrian.

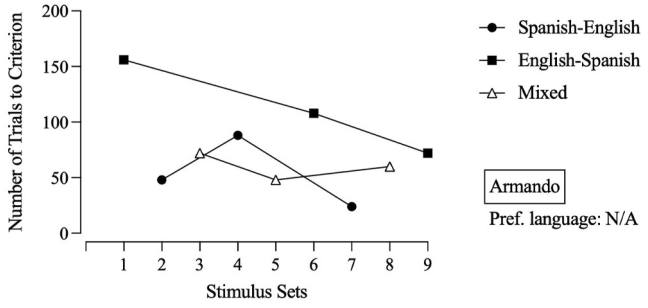

FIGURE 3 | Trials to the mastery criterion across instructional sequences for Armando.

continued (i.e. after the first training set), the trials required to reach the mastery criterion converged to similar levels across conditions. This pattern of responding was clear for Gabby and Adrian; Armando's graph shows a clearer differentiation with the English-Spanish sequence requiring more training trials to reach the mastery criterion as compared to the mixed and Spanish-English instructional sequences.

Comparisons of the average number of training trials required to reach the mastery criterion by training sequence for Gabby, Adrian, and Armando are displayed in Figures 4, 5, and 6, respectively. For Gabby and Armando, the Spanish-English sequence produced the most efficient responding, and for Adrian the mixed sequence was the most efficient. Both Adrian and Gabby demonstrated a clear convergence of levels of and undifferentiated responding across all three instructional sequences after the first training set. Armando required the fewest

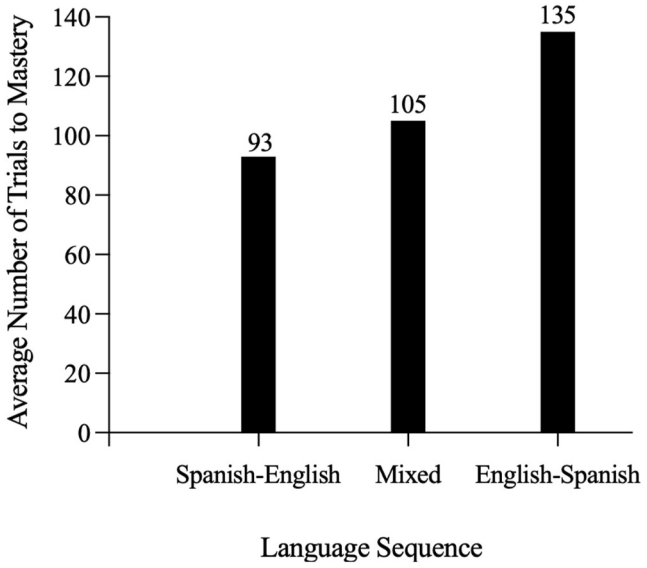

FIGURE 4 | Average number of trials to the mastery criterion across instructional sequences for Gabby.

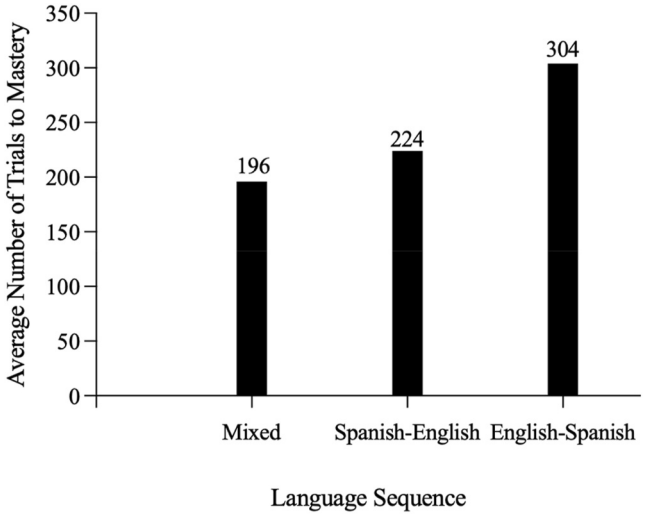

FIGURE 5 | Average number of trials to the mastery criterion across instructional sequences for Adrian.

number of training trials for responding to reach the mastery criterion in the Spanish-English sequence and the greatest number of trials in the English-Spanish sequence. Even though Gabby and Adrian demonstrated a preference for English, the English-Spanish instructional sequence did not prove to be more efficient compared to the mixed and Spanish-English sequences.

4 | Discussion

The results of this study demonstrate that language sequences may or may not impact the rate of acquisition of listener targets in response to instructions in two languages in children with autism. Additionally, language preference for or amount of exposure to a given language does not necessarily improve the rate of acquisition of listener skills in that language. Finally, and

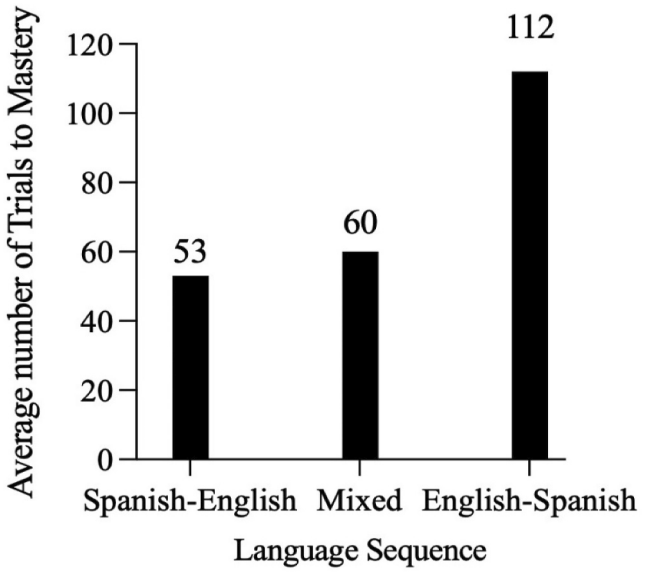

FIGURE 6 | Average number of trials to the mastery criterion across instructional sequences for Armando.

importantly, the results also demonstrate that children with autism can successfully learn to respond to instructions in both their familial and the culturally dominant language.

There were some noteworthy differences in the participants' behavior during the language preference assessments. Both of the participants that showed a language preference (for English) engaged in more conversational behavior and interaction with the experimenter when they chose the English table. When they selected the Spanish table, they primarily spoke in English, even though the experimenter only spoke in Spanish. For example, when Gabby chose the Spanish table, initially she would respond to the experimenter in Spanish, but then for the remainder of the trial, she ignored the experimenter's comments and engaged in quiet independent play. When Adrian chose Spanish during his preference assessment, he would respond to the experimenter in English and would at times say, "What?". So, it is possible that when Gabby and Adrian selected the Spanish table during the language preference assessment, this may have been influenced by other variables and not based on a preference, such as the novelty of switching to a different table. It could also have been the case that while they were not interested in speaking in Spanish when selecting the Spanish table, they may have preferred listening to Spanish at that moment, or hearing the therapist speak in Spanish, since prior to beginning the study the communication in this setting was only English. Armando engaged in conversation and interactive play equally at each table during the language preference assessment, and interestingly, he spoke both languages at both tables. For example, on one occasion, he selected the Spanish table and spent 2 minutes speaking Spanish, 2 minutes speaking English, and then switched back to Spanish for the remaining minute.

Examining trial-by-trial data for the English-Spanish and Spanish-English training sequences for Gabby reveal that the number of trials required to reach the mastery criterion for her preferred language (English) were fewer compared to the non-

preferred language (Spanish). For example, even though the total number of training trials to mastery for set 5 in the Spanish-English sequence was 108, she mastered the targets in Spanish in 72 trials, but only required 36 for the same targets in English. This was the case for 7/8 stimulus sets when languages were trained separately. Adrian, however, consistently mastered the second language targeted in the sequence in fewer trials compared to the first, for both the English-Spanish and Spanish-English sequences. Therefore, it is unclear if and in what way language preference impacts the rate of acquisition of listener responding and efficiency of training sequences. It may be the case that language preference may impact learning when targeting other types of responding like speaker behavior.

When considering the mean number of trials to mastery across conditions, for all three participants the English-Spanish sequence was the least efficient (Figures 4-6). However, when evaluating the data on a session-by-session basis, we can see that for both Gabby and Adrian, responding across all three instructional sequences was undifferentiated (Figures 1 and 2). For Armando, responding is undifferentiated between the Spanish-English and mixed conditions, but there was differentiation with the English-Spanish condition, which was shown to be the least efficient instructional sequence (Figure 3). The data suggest that for Gabby and Adrian, sequence of instruction did not matter, whereas for Armando, the English-Spanish sequence was consistently the least efficient. Gabby and Armando both showed preferences for English and showed undifferentiated responding across the instructional sequences. Armando did not show a language preference but showed differentiated responding in the English-Spanish instructional sequence. These results suggest that language preferences do not influence a faster rate of acquisition of listener targets when initiating training with the preferred language (Gabby and Adrian). This also suggests that greater daily exposure to a given language in the educational or clinical environment does not result in a faster rate of acquisition of listener targets when initiating training with that language (Gabby, Adrian, and Armando).

For Gabby and Adrian, the required number of training trials to mastery in the English-Spanish condition decreased over the course of the study and responding was at the same level compared to the other two instructional sequences. This could suggest that they may have started engaging in other mediating (overt and covert) verbal behavior that improved the rate of acquisition in the English-Spanish training sequence over time. Initiating treatment with the language that they normally do not speak in their educational/clinical environments throughout the day (Spanish), may have required them to engage in the relevant mediating verbal behavior from the start of training, thereby increasing the rate of acquisition. However, when initiating treatment only in the language they normally speak throughout each day may not have influenced this mediating verbal behavior, thereby initially decreasing their rate of acquisition during this instructional sequence (English-Spanish).

The Naming Theory (Horne and Lowe 1996; Miguel 2018) may offer one way to interpret the results. Naming occurs when an individual engages as both a speaker and listener with respect to events and stimuli in their environment. With Bidirectional Naming (BiN; Miguel 2018), when an individual is taught to respond to a given stimulus as a listener, they can respond to the same stimulus as a speaker in the absence of direct training, and vice versa. Additionally, an individual who can engage in BiN can observe other individuals respond to stimuli as speaker and listener, and without direct training they can respond to those same stimuli as both a listener and speaker. It is likely that the participants in this study engage in BiN, and engaged proficiently as both speaker and listener (and responded to their own speaker behavior as a listener and vice versa), during training sessions. Gabby engaged in overt echoic responding during all conditions (engaged as a speaker in response to instruction), and at times engaged in motor responses to "match" or represent the stimuli in the set (engaged as a listener in response to her own speaker behavior). For example, when learning the word "chickpea," she echoed "chickpea" and would at times put her arms to her side and move them like a chicken flapping its wings. Armando would partially echo the instruction provided by the experimenter. For example, the experimenter would say, "Toca el clavo" and Armando would reply "clavo?" This demonstrated that he engaged as a speaker in response to the experimenter's instruction and then visually scanned the cards and responded to the clavo as a tact, which then jointly controlled (Lowenkron 2006) his selection response (responding as a listener). Adrian demonstrated intraverbal naming (Miguel 2018) most often during the mixed condition. e.g., he would say "pomegranate is granada" or "Granada is pomegranate" during the mixed condition. It may have been the case that this intraverbal mediating verbal behavior produced the most efficient responding for Adrian during the mixed training conditions.

The social validity of this study is important to consider. Parents of bilingual children with autism are often concerned about whether continuing to teach and speak to their children in their familial/native language will negatively impact their learning. The results of this study showed it is possible for bilingual learners with autism to learn both the familial and the culturally dominant languages both sequentially and concurrently. Although there were differences in the rate of acquisition across instructional sequences, all of the participants were able to learn to respond to instructions in both languages. Therefore, it is important, when working with multi-lingual families to consider parental, and when possible, consumer language preferences during ABA programming. These data, in conjunction with the published data on bilingual learners with autism, suggests that targeting both languages is not only possible, but is also beneficial for learning, social development, and imperative to providing culturally responsive and socially significant care.

One of the limitations of this study was that only listener skills were targeted so the generalizability of these outcomes is limited to listener responding, specifically selection responses. It is possible that language preference would play more of a role in aiding acquisition for speaking skills, such as tacts or intraverbals. Additionally, the languages that were targeted were both western languages and share an alphabet. Future research should examine the effects of preference and instructional sequences with speaker responses, and with a combination of western and non-western languages (e.g., English and Japanese). Future research should also examine the effects of emergence of responding across listener responding and verbal

operants (e.g., teaching manding, then assessing for the emergence of listening skills, and vice versa), on the rate of acquisition of a second/foreign language in children with and without autism and developmental disabilities.

It would also be important to assess the impact of instructional sequences and preferences on the rate of acquisition for early learners, and most especially for those who do not yet engage in naming, in order to evaluate the role of naming in the acquisition of listener skills in response to two languages. In order to provide effective and culturally responsive services, additional research on bilingualism and autism is warranted on how to better serve this growing population.

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Ethics Statement

This study was approved by the University of Houston-Clear Lake, Committee for the Protection of Human Subjects.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Raw data are available from the first author.

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