JEHDI
The Journal of Early Hearing Detection and Intervention
NCHAM National Center for Hearing Assessment and Management Utah State University™
2022; 7(1): 42–53

Adaptation of the Conditioned Assessment of Speech Production in Spanish

Alliete R. Alfano, PhD[1]
Daniel Gonzalez, MS[1]
David J. Ertmer, PhD[2]
[1]Department of Communication Sciences and Disorders, Florida International University, Miami, FL
[2]Department of Speech, Language, and Hearing Sciences, Purdue University, West Lafayette, IN

Abstract

Purpose: The purpose of this article is to describe the adaptation of the Spanish version of the Conditioned Assessment of Speech Production (CASP).

Method: The authors adapted each segment into Spanish, then had 41 participants complete a survey to determine if each adapted segment was representative of the Spanish phonologic system. Thirty-six children (half with typical hearing, half with hearing loss) completed the CASP in English and Spanish. Paired samples *t*-tests were run to compare English and Spanish CASP scores between children with hearing loss and those with typical hearing.

Results: All segments were adapted as needed into Spanish. There was no statistical difference between the English CASP scores (18.61 ± 2.03) and Spanish CASP scores (18.78 ± 1.99) for the children with typical hearing. Similarly, there was no statistical difference between the English CASP scores (16.78 ± 3.44) and Spanish CASP scores (16.67 ± 3.41) for the children with hearing loss. Children with typical hearing scored statistically significantly higher on the English and Spanish CASP than children with hearing loss.

Discussion: The CASP-S is an appropriate Spanish adaptation of the CASP, which has been field-tested for use with young Spanish-speaking children with hearing loss.

Keywords: CASP-S, Spanish early speech production, speech assessment

Acronyms: AF = Advanced Forms; BCS = Basic Canonical Syllables; CASP-S = Conditioned Assessment of Speech Production–Spanish; CI = cochlear implant; EHDI = early hearing detection and intervention; JCIH = Joint Committee on Infant Hearing; PC = Precanonical; SAEVD-R = Stark Assessment of Early Vocal Development-Revised

Correspondence concerning this article should be addressed to: Alliete R. Alfano, PhD, Florida International University, 11200 SW 8th St, AHC3-437, Miami, FL 33199. Email: aalfano@fiu.edu

Early speech production prepares young children motorically to build their repertoire for early language development (Vihman et al., 1985). This motoric patterning leads to more advanced speech, which lays the building blocks for early vocabulary in young children. Children with hearing loss are at risk for speech delays due to limited auditory access (Joint Committee on Infant Hearing [JCIH], 2019; Oller & Eilers, 1988). Early identification and sensory aid use (e.g., hearing aids and cochlear implants) can counteract delays in speech production, and rapid development of early speech sounds typically occurs when sensory aid use begins (Apuzzo & Yoshinaga-Itano, 1995; Robinshaw, 1995). Assessing the early speech productions of children with hearing loss is crucial to identify those who are at-risk or already delayed so they can begin targeted therapeutic interventions (Ambrose et al., 2014; Eilers & Oller, 1994; Moeller et al., 2007a; Yoshinaga-Itano et al., 2017). Although there are assessments that assess early vocalization of English-speaking children, there are few for children with hearing loss and even less so for children with hearing loss who speak Spanish.

The Conditioned Assessment of Speech Production (CASP) is an efficient tool to assess the early vocal productions of young children with hearing loss who speak English (Ertmer & Stoel-Gammon, 2008). Due to the differences between English and Spanish phonological systems, the CASP is not an adequate tool to use with Spanish-speaking children with hearing loss. The Conditioned Assessment of Speech Production-Spanish (CASP-S) was adapted as a more appropriate assessment tool to document the early vocal productions of young children with hearing loss who speak Spanish. The purpose of this article is to describe the adaptation and initial field-testing of the CASP-S. The CASP-S was first adapted into Spanish segments by the authors. Then surveys were presented to Spanish-speaking speech-language pathologists and graduate students to identify appropriateness of the segments selected. Finally, field testing was conducted with 18 pairs of age- and gender-matched young Spanish-speaking children, half of whom have hearing loss.

Speech Development in Children with Typical Hearing

There is a large body of research that describes in depth the speech development of children who speak English (Poole, 1934; Prather et al., 1975; Sander, 1972; Templin, 1957) from which general guidelines were established for expected development of English speech production. Of particular importance for early vocalizations is the onset of canonical babbling, which is typically developed by 10 months of age (Nathani et al., 2007; Stark et al., 1993), and is universal across different languages (Ertmer & Moreno-Torres, 2009). This knowledge assists in understanding and identifying typical versus atypical development in even the earliest expected developing vocalizations in young children, regardless of language.

Spanish speech development has some distinctions from English speech development (Canfield, 1981; Dalbor, 1980; Gildersleeve-Neumann et al., 2008; Jimenez, 1987; Navarro, 1968). For example, Spanish does not contain all the same phonemes as English. Spanish has fewer phonemes than English, has some phonemes not represented in English, and uses its consonants (C) in phonologically different ways, even when those consonants are shared with English (Acevedo, 1993; Goldstein, 2015; Jimenez, 1987). Additionally, the majority of Spanish words end in vowels (V) and there are only 5 consonants that are used in the final position of words (i.e., /n/, /s/, /l/, /r/, and /d/) (Gildersleeve-Neumann et al., 2008). Spanish has a smaller number of initial consonant clusters, /s/ is never combined with another consonant in an initial cluster in Spanish, and Spanish has two types of "r" sounds (a tap /ɾ/ that is similar to an English flap /d/ and a trilled /r/), neither of which are produced like the English retroflex /ɹ/. Additionally, although English and Spanish share most of their phonemes and thus their ages of acquisition are very similar, there are more late-acquired fricative sounds in English than in Spanish; thus, Spanish consonants are typically mastered much earlier than English consonants (Acevedo, 1993). Due to these differences between English and Spanish speech development, English normative data for speech production beyond the earliest vocal productions cannot be applied to Spanish and Spanish-specific normative data have been developed (Acevedo, 1993; Goldstein, 2015; Jimenez, 1987).

Vocal Development in Children with Hearing Loss

The first months of vocal development, including crying, are very similar between children with and without hearing loss (Oller & Eilers, 1988; Stoel-Gammon & Otomo, 1986). Changes begin with vocal play and children with hearing loss will have delayed or deviant vocal development without the use of sensory aids. Several studies have confirmed that improved auditory access through sensory aids is associated with improvements in speech development in English similar to typically hearing peers. As Universal Newborn Hearing Screening has become the norm for infants born in the United States, more infants are being identified with hearing loss at earlier ages than before (JCIH, 2019). The Joint Committee on Infant Hearing emphasizes the importance of Early Hearing Detection and Intervention (EHDI) activities for identification of hearing loss as early as birth. The goal of their efforts has led to earlier identification of hearing loss and, subsequently, earlier entrance into early intervention. The JCIH's specific recommendations are known as 1-3-6 Goals, wherein all infants should have their hearing screened by no later than one month of age, hearing loss should be confirmed by three months of age, and early intervention services should begin as soon as diagnosis but no later than six months of age. Longer length of time of sensory aid use is associated with better speech outcomes, including more prelinguistic vocalizations, more complex structures, and faster prelinguistic/speech development when compared to children who are identified later and begin use of sensory aids later (Ambrose et al., 2014; Binos et al., 2013; Eilers & Oller, 1994; Fagan, 2014; Fulcher et al., 2012; Moeller et al., 2007a; Moeller et al., 2007b; Pratt et al., 2007; Salas-Provance et al., 2014; Tomblin et al., 2008; Tomblin et al., 2014; von Hapsburg & Davis, 2006). These findings demonstrate the importance of earlier identification and earlier use of sensory aids.

Several studies address early vocal development for young children with cochlear implants (CIs) and found that the use of precanonical vocalizations decreased as they produced more advanced speech-like vocalizations, and that vocal development milestones were typically reached with fewer months of hearing experience than for children with typical hearing (Ertmer et al., 2007; Ertmer, et al., 2013; Ertmer & Jung, 2012a, 2012b). Children with CIs likely achieve vocal developmental milestones with fewer months of hearing than hearing peers because they are older when they begin hearing. Cognitively, they are ready for word learning and they already have semantic concepts (visual representations or signs) to associate with a spoken label (Ertmer et al., 2007). This may be why children with cochlear implants "skip" the babbling stages. Additionally, it is important to stress assessment of early speech sound production to identify children with hearing loss who may be at risk for delays in speech development (Ambrose et al., 2014; Moeller et al., 2007b; Eilers & Oller, 1994). However, assessment tools are needed to assess early speech sounds in the target language.

In Spanish, there is extremely limited research on the early speech production of Spanish-speaking children with hearing loss who use sensory aids. Sosa and Bunta (2019) found that children with CIs had lower consonant and vowel accuracy and whole-word variability than peers with typical hearing. However, there were no differences between those rates in bilingual and monolingual children who were matched by hearing status. Additionally, bilingual language exposure did not appear to have a negative effect on the phonologic development of children with CIs. Moore et al. (2006) documented the early Spanish speech development of a toddler who had a CI activated at 20 months of age. They found that early speech production was similar to CI recipients learning English, but that post-implant overall production accuracy was greater than for English-speaking peers. Finally, Moreno-Torres (2014)

studied 8 Spanish-speaking children with hearing loss who were implanted before the age of 24 months. He found that the children's first words were similar to the types of babbling they were using and that their more advanced productions were constrained by Spanish prosodic structures. Taken all together, these few studies highlight two important findings. First is the urgent need for more research in the area of early vocal productions of Spanish-speaking children with hearing loss. Second is the need to consider that since the phonological systems of English and Spanish differ, it is necessary to produce language-specific norms, assessments, and interventions in Spanish for Spanish-speaking children with hearing loss.

Test Adaptations

Assessments are being translated and adapted at a higher rate than they were before (Matsumoto & van de Vijver, 2011). Test adaptations involve deciding whether the assessment can measure the same constructs in a different language, selecting appropriate items to translate, deciding on appropriate changes to be made in preparing a test for a second language, adapting it, and ensuring both forms of the assessment are equivalent. Assessments need to be adapted to facilitate comparative studies of achievement across cultural and language groups, can be more cost-effective than developing new tests, and can achieve fairness in assessment methods through establishment of equivalence of scores (Hambleton et al., 2012). Adaptations require significantly more than the translation of literal words from one language to another and are more highly involved with ensuring that they address the same concepts, words, and expressions that are culturally and linguistically equivalent in a second language and culture (Hambleton et al., 2012).

Adaptation of the CASP

The Conditioned Assessment of Speech Production (CASP) was developed to be a useful criterion-referenced vocal stimuli test that assesses vocal development in English-speaking children with hearing loss between the ages of 18 and 48 months (Ertmer & Stoel-Gammon, 2008). The CASP has been used to monitor vocal development of children with hearing loss through imitative and prelinguistic speech patterns, but these speech stimuli solely test English phonology. It is a time-efficient tool that allows quick regular clinical use (Ertmer & Jung, 2012a). It was developed on the premise that advancements in auditory access allow for improvements in vocal development for children with hearing loss. The benefits of the sensory aids are demonstrated when children's imitations and vocalizations become more complex, phonetically varied, and speech-like. Additionally, it was demonstrated that young children could be conditioned to imitate speech stimuli from a familiar person during a game-like activity.

The CASP used two published investigations as the basis for its development, both of which used the Stark Assessment of Early Vocal Development-Revised (SAEVD-R; Nathani et al., 2006), which classifies prelinguistic utterances of typically developing infants and toddlers during play with their mothers. The SAEVD-R was developed to use perceptual and articulatory characteristics of vocalizations to capture infant vocal productions. In the first study, Nathani et al. (2006) examined 30 infants (from 2 weeks to 20 months of age), recording their representative sound production behaviors 5 times within their age-group time span. From that, five levels of vocalizations were identified that describe typical infant and toddler vocalization in English-speakers that progress developmentally with age: Level 1: reflexive sounds, Level 2: control of phonation, Level 3: expansion, Level 4: basic canonical syllables, and Level 5: advanced forms.

In the second study, Ertmer et al. (2007) followed 7 children (4 girls and 3 boys) with hearing loss longitudinally. These children ranged from 10 to 36 months at the time they received CIs. Children were seen for two 30-minute data collections within 2 months before activation of their CIs, and at monthly intervals following CI activation until they met the criteria for completing vocal development on the SAEVD-R. Sessions were audio- and video-recorded and utterances were counted in each 10-minute segment. Results indicated longer periods of vocal development for children who were younger and that, typically, younger children completed vocal development earlier than children who were older when implanted. Five of the 6 children followed the expected hierarchical sequence of the SAEVD-R. Of particular interest in this study was the length of time it took for children to establish adultlike vocalizations (Level 4, basic canonical syllables and Level 5, advanced forms). Four of the 5 children who had not yet reached Level 4 at the beginning of the study were able to complete it within 17 months of CI activation. Six of the 7 children who had not yet reached Level 5 at the beginning of the study were able to do so within 11 months after CI activation.

Assessment tools like the CASP have allowed clinicians to assess early vocalizations for young children with hearing loss who speak English. However, appropriate assessment of children from homes that speak other languages than English is not possible with the CASP. Eighteen percent of the current U.S. population (325+ million individuals) is estimated to be Hispanic or Latino (United States Census Bureau, n.d.a), which represents the largest minority group in the United States. Additionally, over 21% (71+ million) of the population speaks a language other than English, with more than 27 million individuals reporting speaking English "less than very well". The Hispanic/Latino population is also expected to triple in size, making up 29% of the U.S. population by 2050 (Passel & Cohn, 2008). Hispanics are known to have a higher prevalence of hearing loss when compared to non-Hispanic Whites and non-Hispanic Blacks (Goman & Lin, 2016; Mehra et al., 2009), and about 1.8 million of the 11 million U.S. children under age 18 with at least 16 dB hearing loss are Hispanic (Niskar et al., 1998; United States Census Bureau, n.d.b). While the number of bilingual English/Spanish speakers continues to grow in the United States, the research on

bilingual (English/Spanish) and Spanish monolingual speech development in young children with hearing loss is extremely limited.

Since it is known how important it is to monitor progress in spoken language development soon after fitting of sensory aids, there is a pressing need to develop tools for children who are from Spanish-speaking homes. As the CASP only assesses English phonological systems, it is not an appropriate assessment for testing the emerging phonological system of Spanish-speaking children. Therefore, an appropriate assessment for Spanish-speakers is needed.

Rationale for the Adaptation of the CASP-S

The CASP-S is a Spanish adaptation of the CASP developed by Ertmer and Stoel-Gammon (2008). In line with the CASP, the CASP-S is a time efficient, game-like activity that measures prelinguistic vocal development in children with hearing loss by having them produce 10 different vocal utterances that follow a hierarchical sequence of development. These utterances move through the final 3 levels of vocal development of the SAEVD-R, namely the Precanonical (PC) level, the Basic Canonical Syllables (BCS) level, and the Advanced Forms (AF) level.

Administration and Scoring of the CASP-S

Administration of the CASP-S is the same as the CASP, and in-depth procedures can be found in Ertmer and Stoel-Gammon (2008). The clinician engages the parent to model for their child by providing models of the 10 utterances. Initially, the clinician role-plays with the parent by modeling the utterance for the parent in the game-like activity. The parent listens and repeats while the child observes the interaction. The parent's imitation is reinforced by having them stack a ring on a ring stacker toy. Following the clinician-parent interaction, the parent models the same utterance for the child and encourages the child to imitate. Having the parent model the utterance is advantageous for the child because a familiar partner is being used as the source of the stimulus. In sum, the CASP-S follows a clinician to parent, parent to child sequence of events per item. Complete instructions are given in Appendix A. The child's imitative response is then scored using a graduated scoring scale: 0 = *no attempt*, *not a close match*, 1 = *partially acceptable match*, and 2 = *fully acceptable match*. Criteria for each CASP-S item are included on the score sheet (Appendix B).

Method

The adaptation of the CASP-S was completed in three phases. For the adaptation phase, the specific segments were adapted as needed to accurately represent Spanish phonological development. During the construct validity phase, the adapted segments were presented to a panel of native Spanish-speakers to identify which segments were the best representations of Spanish phonology. Finally, the validated segments were field-tested with children with hearing loss and age- and gender-matched peers.

Segment Adaptation Phase

Segment Rationale for Changes from CASP to CASP-S

To determine Spanish-appropriate segments, each item of the CASP was reviewed and adapted as needed by the authors based on general Spanish phonology. The following adapted segments for CASP-S moved to the validation stage (see Table 1). For vowels, Spanish has a basic five-phonemic vowel system of /i/, /e/, /a/, /o/, /u/, as opposed to English, which has a larger number of vowels. Due to the difference in the number of vowels, several vowel changes were required in the adapted version and all 5 vowels are represented in CASP-S. For consonants, the English consonants used in the CASP (i.e., /b/, /m/, /w/, /s/, /k/, /n/) are consonants used in Spanish and are expected to be mastered by 4 years and 6 months in typically developing Spanish-speaking children (Acevedo, 1993). Therefore, these consonants did not require adaptations and are all represented in CASP-S. The following vowels and consonants were used in each of the 10 total segments plus warm-up sounds:

Warm-up Sounds (open vowels for imitation and conditioning practice, elicited as a warm-up activity before the administration of CASP-S): the visually salient high back vowel /u/ and the mid back vowel /o/ are both found in Spanish and were not changed.

For Level 1 PC: precanonical vocalizations lack phonetic content and adult-like timing of true syllables. Because these vowels are not visually salient, they require the child to rely mainly on auditory information for imitation. The original CASP uses the mid-central /ʌ/, which is not in the vowel repertoire in Spanish. Therefore, the mid-low vowel /a/ was used. For item 2, the CASP used /i/, which is represented in the Spanish vowel repertoire. Consequently, that vowel was not changed for the CASP-S. For item 3, the CASP uses the low-front /æ/, which is not in the vowel repertoire in Spanish and the mid-front [e] replaced it.

For Level 2 BCS: basic canonical syllables consist of consonant-vowel (CV) syllable shapes with adult-like timing. Two kinds of canonical syllables are presented in the CASP, 3 CV syllables with highly visible consonants and 2 CV syllables containing consonants with minimal speech reading cues. The highly visible consonants emerge early in life, and in contrast, the less visually salient consonants represent later emerging sounds. As the consonants did not change, the only change made to the CASP-S was for the vowel. The low-back vowel /ɑ/ changed to the mid-low vowel /a/ for all segments.

For Level 3: Advanced Forms utterances include a consonant plus a diphthongized vowel syllable and a CVC syllable. Speechreading cues are minimal in these stimuli, thus requiring children to rely mainly on their auditory perception ability. The segment [naɪ] was judged an appropriate segment for Spanish and was not changed. By the age of 2, almost half the syllable types produced by Spanish speaking children are CV syllables. Accordingly, the consonants in CASP-S mostly appear in CV syllable

Table 1

Adaptations to the Conditioned Assessment of Speech Production (CASP)

	CASP	CASP-S
Warm-up Sounds	/u/ and /o/	/u/ and /o/
Level 1: Precanonical vocalizations		
1. prolonged central vowel in isolation	1. /ʌ/	1. /a/
2. two high-front vowels	2. /i/ /i/	2. /i/ /i/
3. three low-front vowels	3. /æ/ /æ/ /æ/	3. /e/ /e/ /e/
Level 2: Basis Canonical Syllables		
4. CV syllable with bilabial stop consonant	4. /bɑ/	4. /ba/
5. CV syllable with bilabial nasal	5. /mɑ/	5. /ma/
6. CV syllable with bilabial glide	6. /wɑ/	6. /wa/
7. CV syllable with velar stop	7. /kɑ/	7. /ka/
8. CV syllable with lingua-alveolar fricative	8. /sɑ/	8. /sa/
Level 3: Advanced Forms		
9. C+ diphthong syllable	9. /nai/	9. /nai/
10. CVC	10. /tʌk/	10. /kon/ /don/ /tok/

Note. Adaptations are shown from CASP (English version) to CASP-S (Spanish version). C = consonant; V = vowel.

structures. Given the phonotactic constraints of Spanish, it should be noted that the diversity of consonants in CVC syllables is limited, and selecting a representative CVC sequence was the most challenging aspect of adapting and validating the CASP-S. For this final item, three segments were selected as appropriate: [kon], [don], and [tok].

Construct Validity of CASP-S

Participants

Following approval from Florida International University's Institutional Review Board, 44 participants who self-identified as native Spanish speakers listened to a presentation about CASP and CASP-S in the construct validity phase of the CASP-S. They were then asked to complete a survey about the representativeness of the Spanish segments selected for Advanced Form Level of the CASP-S. Participants included 37 speech-language pathology graduate students, 2 professors in the Communication Sciences and Disorders Department at Florida International University and 5 speech-language pathologists in Miami. Participants ranged in age from 21 to 70 years of age. Participants were given a scale to self-rank their Spanish proficiency on the Interagency Language Roundtable (ILR) Speaking Skill Scale. Criteria to be considered sufficiently proficient to participate in the study was to be at a level 2 or above on the ILR scale. Three participants did not meet criteria for participation in the study and were not included in the data analysis as 2 failed to state their level of proficiency and one had a proficiency level below 2. Forty-one total participants' data were analyzed. Spanish dialects represented by the 41 participants were Cuban, Colombian, Dominican, Venezuelan, Uruguayan, Panamanian, Argentinian, Nicaraguan, Peruvian, and Mexican. Thirteen of the 41 participants were immigrants.

Construct Validity Results

Forty-one out of 44 surveys were considered when determining the representativeness of the Spanish segments proposed in CASP-S. The segments chosen for Level 1 and Level 2 of CASP-S were determined to be representative of an emerging Spanish phonological system. For Level 3, all participants agreed that the segment in the original English CASP for "alveolar nasal plus diphthong" /naɪ/ was an appropriate equivalent in Spanish and thus, should remain on the CASP-S. For the CVC item, 56% agreed that /kon/ was the most representative CVC segment, 27% agreed that /don/ was the most representative, 10% agreed that /tok/ was the most representative, and the remaining 7% agreed that a combination of either /kon/ and /tok/ or /don/ and /tok/ were equally the most representative. Seventeen percent felt that /tok/ was unrepresentative, 2% felt that /don/ was unrepresentative, and 0% felt that /kon/ was unrepresentative. In sum, /kon/ was determined to be the most representative CVC sample.

Field Testing

Eighteen pairs of English-Spanish bilingual children were administered the CASP and the CASP-S, all of whom were from bilingual homes per parental report. Half of the children had hearing loss and the other half had typical hearing. Inclusion criteria for children with hearing loss was as follows: identified with moderate to profound hearing loss by 10 months of age, began wearing sensory aids (hearing aids or CIs) by 17 months of age, had no additional disabilities, were in schools where spoken language was used, and were not exposed to sign language. Inclusion criteria for children with typical hearing was as follows: had typical speech, language, and hearing development, and were matched to the children with hearing loss by gender and by age, within 4 weeks of age. Eighteen children with hearing loss and 18 children with typical hearing met inclusionary criteria and participated in the study.

Paired samples *t*-tests were run to determine if there were differences between English and Spanish scores for the children with typical hearing, between English and Spanish scores for children with hearing loss, in English scores between children with hearing loss and children with typical hearing, and in Spanish scores between children with hearing loss and children with typical hearing. There was no statistical difference between the English CASP scores (18.61 ± 2.03) and Spanish CASP scores (18.78 ± 1.99) for the children with typical hearing. Similarly, there was no statistical difference between the English CASP scores (16.8 ± 3.44) and Spanish CASP scores (16.67 ± 3.41) for the children with hearing loss. Children with typical hearing scored significantly higher (18.61 ± 2.03) on the English CASP than children with hearing loss (16.78 ± 3.44), a statistically significant increase of 1.83, $t(17) = 2.829$, $p < .05$. Children with typical hearing also scored higher (18.78 ± 1.99) on the Spanish CASP than children with hearing loss (16.67 ± 3.41), a statistically significant increase of 2.11, $t(17) = 2.801$, $p < .05$.

Discussion

The CASP-S is an efficient, easy to administer adaptation of the CASP. The adaptation was completed by making changes to accurately represent Spanish phonology, validating the changes through field testing by native Spanish-speaking speech-language pathologists and graduate students, and field testing with 18 pairs of young English and Spanish-speaking children. The results indicate that the CASP-S was able to capture the early Spanish speech vocalizations in young children with hearing loss and was sensitive enough to identify statistically different productions in a similar way as the English CASP. Additionally, it was able to identify statistically different performance between children with typical hearing and children with hearing loss (face validity). These results demonstrate that the CASP-S is an appropriate measure to assist clinicians' ability to accurately document production and detection of early vocalizations and can be used to monitor changes in prelinguistic speech development in young Spanish-speaking children with hearing loss with repeated administration. This adaptation is a step forward that helps fill the gap of limited assessment procedures for young Spanish-speaking children with hearing loss. Future studies should be completed to measure the validity and reliability of the CASP-S, as well as to establish expected scores by age to use this assessment as a criterion referenced tool. This would allow clinicians to more specifically identify an age-level for a child's vocalizations, which could then be compared to both the child's chronological age and hearing age. This information would then assist in shaping individualized intervention goals for Spanish-speaking children with hearing loss.

Limitations

There is little research on the vocal development of Spanish-speaking children with hearing loss. Additional research, test development, and test adaptations should be conducted in this area to better serve this growing population. This study was limited in size and geographical area, and therefore, the results may not be generalizable to all Spanish-speaking populations. This study may be used as the impetus for future test adaptations.

References

Acevedo, M. A. (1993). Development of Spanish consonants in preschool children. *Journal of Childhood Communication Disorders, 15*(2), 9–15. https://doi.org/10.1177/152574019301500202

Ambrose, S. E., Berry, L. M. U., Walker, E. A., Harrison, M., Oleson, J., & Moeller, M. P. (2014). Speech sound production in 2-year-olds who are hard of hearing. *American Journal of Speech-Language Pathology, 23*(2), 91–104. http://doi.org/10.1044/2014_AJSLP-13-0039

Apuzzo, M. L, & Yoshinaga-Itano, C. (1995). Early identification of infants with significant hearing loss and the Minnesota Child Development Inventory. *Seminars in Hearing, 16*, 124–137.

Binos, P., Okalidou, A., Botinis, A., Kiriafinis, G., & Vital, V. (2013). Suprasegmental features of CI children via classification of pre-linguistic utterances: Two longitudinal case studies. *Journal of Hearing Science, 3*(1), 37–46.

Canfield, D. L. (1981). *Spanish pronunciation in the Americas*. The University of Chicago Press.

Dalbor, J. B. (1980). *Spanish pronunciation: Theory and practice* (2nd ed.). Holt, Rinehart & Winston.

Eilers, R. E., & Oller, K. (1994). Infant vocalizations and the early diagnosis of severe hearing impairment. *Journal of Pediatrics, 124*(2), 199–203. https://doi.org/10.1016/S0022-3476(94)70303-5

Ertmer, D., & Jung, J. (2012a). Monitoring progress in vocal development in young cochlear implant recipients: Relationships between speech samples and scores from the Conditioned Assessment of

Speech Production (CASP). *American Journal of Speech-Language Pathology, 21*(4), 313–328. https://doi.org/10.1044/1058-0360(2012/11-0110)

Ertmer, D., & Jung, J. (2012b). Prelinguistic vocal development in young cochlear implant recipients and typically developing infants: Year 1 of robust hearing experience. *Journal of Deaf Studies and Deaf Education*, *17*, 116–132. https://doi.org/10.1093/deafed/enr021

Ertmer, D. J., Jung, J., & Kloiber, D. T. (2013). Beginning to talk like an adult: Increases in speech-like utterances in young cochlear implant recipients and typically developing children. *American Journal of Speech-Language Pathology*, *22*(4), 591–603. https://doi.org/10.1044/1058-0360(2013/12-0058)

Ertmer, D. J., & Moreno-Torres, I. (2009). El desarrollo vocal en niños sordos de familias Hispanohablantes [Vocal development in young children from Spanish-speaking families]. *Revista de Logopedia, Foniatria y Audiologia, 29*, 153–164. https://doi.org/10.1016/S0214-4603(09)70024-5

Ertmer, D. J., & Stoel-Gammon, C. (2008). The conditioned assessment of speech production (CASP): A tool for evaluating auditory-guided speech development in young children with hearing loss. *The Volta Review, 108*(1), 59–80.

Ertmer, D. J., Young, N. M., & Nathani, S. (2007). Profiles of vocal development in young cochlear implant recipients. *Journal of Speech, Language, and Hearing Research, 50*, 393–407. https://doi.org/10.1044/1092-4388(2007/028)

Fagan, M. K. (2014). Frequency of vocalization before and after cochlear implantation: Dynamic effect of auditory feedback on infant behavior. *Journal of Experimental Child Psychology, 126*, 328–338. https://doi.org/10.1016/j.jecp.2014.05.005

Fulcher, A., Purcell, A. A., Baker, E., & Munro, N. (2012). Listen up: Children with early identified hearing loss achieve age-appropriate speech/language outcomes by 3 years-of-age. *International Journal of Pediatric Otorhinolaryngology, 76*(12), 1785–1794. http://dx.doi.org/10.1016/j.ijporl.2012.09.001

Gildersleeve-Neumann, C. E., Kester, E. S., Davis, B. L., & Peña, E. D. (2008). English speech sound development in preschool-aged children from bilingual English–Spanish environments. *Language, Speech, and Hearing Services in Schools, 39*, 314–328.

Goldstein, B. A. (2015). Spanish speech acquisition. In S. McLeod (Ed.), *The International Guide to Speech Acquisition* (pp. 538–551). Thomson Delmore Learning.

Goman, A., & Lin, F. R. (2016). Prevalence of hearing loss by severity in the United States. *American Journal of Public Health, 106*(10), 1820–1822. http://doi.org/10.2105/AJPH.2016.303299

Hambleton, R. K., Merenda, P. F., & Spielberger, C. D. (2012). Adapting educational and psychological tests for cross-cultural assessment. *Lawrence Erlbaum Associates.*

Jimenez, B. C. (1987). Acquisition of Spanish consonants in children aged 3–5 years, 7 months. *Language, Speech, and Hearing Services in School, 18*(4), 357–363. https://doi.org/10.1044/0161-1461.1804.357

Joint Committee on Infant Hearing. (2019). Year 2019 position statement: Principles and guidelines for early hearing detection and intervention programs. *The Journal of Early Hearing Detection and Intervention, 4*(2), 1–44. https://doi.org/10.15142/fptk-b748

Matsumoto, D., & van de Vijver, F. J. R. (Eds.). (2011). *Cross-cultural Research Methods in Psychology.* Cambridge University Press.

Mehra, S., Eavey, R. D., & Keamy, D. G. (2009). The epidemiology of hearing impairment in the United States: Newborns, children, and adolescents. *Otolaryngology-Head and Neck Surgery,140*(4), 461–472. https://doi.org/10.1016/j.otohns.2008.12.022

Moeller, M. P., Hoover, B., Putman, C., Arbataitis, K., Bohnenkamp, G., Peterson, S., Wood, S., Lewis, D., Pittman, A., & Stelmachowicz, (2007a). Vocalizations of infants with hearing loss compared with infants with normal hearing: Part I Phonetic development. *Ear & Hearing, 28*(5), 605–627. http://doi.org/10.1097/AUD.0b013e31812564ab

Moeller, M. P., Hoover, B., Putman, C., Arbataitis, K., Bohnenkamp, G., Peterson, S., Lewis, D., Estee, S., Pittman, A., & Stelmachowicz, (2007b). Vocalizations of infants with hearing loss compared with infants with normal hearing: Part II Transition to words. *Ear & Hearing, 28*(5), 628–642. https://doi.org/10.1097/AUD.0b013e31812564c9

Moore, J., Prath, S., & Arrieta, A. (2006). Early Spanish speech acquisition following cochlear implantation. *The Volta Review, 106*(3), 321–341.

Moreno-Torres, I. (2014). The emergence of productive speech and language in Spanish-learning paediatric cochlear implant users. *Journal of Child Language, 41*(3), 575–599. https://doi.org/10.1017/S0305000913000056

Nathani, S., Ertmer, D. J., & Stark, R. E. (2006). Assessing vocal development in infants and toddlers. *Clinical Linguistics and Phonetics, 20,* 351–369. http://doi.org/10.1080/02699200500211451

Nathani, S., Oller, D. K., & Neal, A. R. (2007). On the robustness of vocal development: An examination

of infants with moderate-to-severe hearing loss and additional risk factors. *Journal of Speech, Language, and Hearing Research*, *50*(6), 1425–1444. http://doi.org/10.1044/1092-4388(2007/099)

Navarro, T. (1968). *Studies in Spanish phonology* (R. D. Abraham, Trans.). University of Miami Press.

Niskar, A. S., Kieszak, S. M., Holmes, A., Esteban, E., Rubin, C., & Brody, D. J. (1998). Prevalence of hearing loss among children 6 to 19 years of age: The third national health and nutrition examination survey. *The Journal of the American Medical Association, 279*(14), 1071–1075. http://doi.org/10.1001/jama.279.14.1071

Oller, D. K., & Eilers, R. E. (1988). The role of audition in infant babbling. *Child Development, 59*(2), 441–449. https://doi.org/10.2307/1130323

Passel, J. S., & Cohn, D. (2008, February 11). *U.S. population projections: 2005–2050.* Pew Research Center. https://www.pewresearch.org/hispanic/2008/02/11/us-population-projections-2005-2050/

Poole, I. (1934). Genetic development of articulation of consonant sounds in speech. *The Elementary English Review, 11*(6), 159–161. www.jstor.org/stable/41381777

Prather, E. M., Hedrick, D. L., & Kern, C. A. (1975). Articulation development in children aged two to four years. *Journal of Speech and Hearing Disorders, 40*(2), 179–191. https://doi.org/10.1044/jshd.4002.179

Pratt, S. R., Schnoor, K., & Friedman, M. (2007). Speech production as a measure of hearing aid benefit in infants and young children with hearing loss. *Perspectives on Hearing and Hearing Disorders in Childhood, 17*, 15–20. https://doi.org/10.1044/hhdc17.1.15

Robinshaw, H. M. (1995). Early intervention for hearing impairment: Differences in the timing of communicative and linguistic development. *British Journal of Audiology, 29*, 315–334.

Salas-Provance, M. B., Spencer, L., Nicholas, J. G., & Tobey, E. (2014). Emergence of speech sounds between 7 and 24 months of cochlear implant use. *Cochlear Implants International, 1*5(4), 222–229. https://doi.org/10.1179/1754762813Y.0000000046

Sander, E. K. (1972). When are Speech Sounds Learned? *Journal of Speech and Hearing Disorders*, *37*(1), 55–63. https://doi.org/10.1044/jshd.3701.55

Sosa, A. V., & Bunta, F. (2019). Speech production accuracy and variability in monolingual and bilingual children with cochlear implants: A comparison to their peers with normal hearing. *Journal of Speech, Language, and Hearing Research, 62*, 2601–2616.

Stark, R. E., Bernstein, L. E., & Demorest, M. E. (1993). Vocal communication in the first 18 months of life. *Journal of Speech and Hearing Research, 36*(3), 548–558. https://doi.org/10.1044/jshr.3603.548

Stoel-Gammon, C., & Otomo, K. (1986). Babbling development of hearing-impaired and normally hearing subjects. *Journal of Speech and Hearing Disorders*, *51*, 33–41. https://doi.org/10.1044/jshd.5101.33

Templin, M. C. (1957). Certain language skills in children, their development and interrelationships. *Institute of Child Welfare, Monograph Series, No. 26*. University of Minnesota Press.

Tomblin, J. B., Oleson, J. J., Ambrose, S. E., Walker, E., & Moeller, M. P. (2014). The influence of hearing aids on the speech and language development of children with hearing loss. *JAMA Otolaryngology Head and Neck Surgery, 140*(5), 403–409.

Tomblin, J. B., Peng, S., Spencer, L. J., & Lu, N. (2008). Long-term trajectories of the development of speech sound production in pediatric cochlear implant recipients. *Journal of Speech, Language, and Hearing Research, 51*(5), 1353–1368. https://doi.org/10.1044/1092-4388(2008/07-0083)

United States Census Bureau. (n.d.a). *QuickFacts: United States.* Retrieved April 11, 2020, from https://www.census.gov/quickfacts/fact/table/US/PST045219

United States Census Bureau. (n.d.b). *Selected characteristics of the native and foreign-born populations 2018. Table S0501.* Retrieved January 31, 2020, from https://data.census.gov/cedsci/table?q=S0501%3A%20SELECTED%20CHARACTERISTICS%20OF%20THE%20NATIVE%20AND%20FOREIGN-BORN%20POPULATIONS&tid=ACSST5Y2018.S0501&hidePreview=true&vintage=2018

Vihman, M. M., Macken, M. A., Miller, R., Simmons, H., & Miller, J. (1985). From babbling to speech: A re-assessment of the continuity issue. *Language, 61*(2), 397–445.

von Hapsburg, D., & Davis, B. L. (2006). Auditory sensitivity and the prelinguistic vocalizations of early-amplified infants. *Journal of Speech, Language, and Hearing Research, 49*(4), 809–822. https://doi.org/10.1044/1092-4388(2006/057)

Yoshinaga-Itano, C., Sedey, A. L., Wiggin, M., & Chung, W. (2017). Early hearing detection and vocabulary of children with hearing loss. *Pediatrics, 140*(2), e20162964; https://doi.org/10.1542/peds.2016-2964

Appendix A

Directions for Administering and Scoring the Conditioned Assessment of Speech Production – Spanish (CASP-S)
Alliete R. Alfano, Daniel Gonzalez, and David J. Ertmer

1. Warm-up Items
   a. After getting the child's attention, the clinician models the first warm-up vocalization (/u/) while holding a toy reinforcer (e.g., ring piece for the ring-post toy) next to her mouth. Models are spoken at slightly louder than conversational intensity level and without unusual visual or intonation cues. The clinician says /u/ or "Say /u/" while looking at the parent.
   b. The parent imitates the modeled vocalization. The parent is given the reinforcer and places it on the post. Parent and clinician respond enthusiastically as the ring is placed on the post.
   c. The parent gets the child's attention and models the same vocalization (i.e., /u/ or "Say /u/") while holding the toy reinforcer next to his or her mouth and looking at the child. When the child vocalizes, he or she is praised and is allowed to place a ring on the post. Any vocalization is reinforced. To maintain a game-like situation, the child is allowed to place the ring on the post even if he or she has made no attempt to imitate.
   d. If the child does not respond to /u/, repeat steps a–c with a warm-up vocalization /o/. If the child attempts to imitate either warm-up item, move to level 1.

NOTE: Clinicians may choose to modify these procedures if the child is familiar with a different, previously established routine for eliciting speech (e.g., if the reinforcer is typically given to the child before an imitative attempt). If the child responds more consistently to the clinician than the parent, the clinician and the parent roles can be reversed. Two familiar clinicians can also administer the CASP-S if parents are unavailable; however, the parent should participate in the process whenever possible. Three adult models are given before the child is expected to imitate each item.

2. Testing
   a. The clinician models the first vocalization of level 1 for the parent as described in step 1a.
   b. The parent imitates the vocalization and receives a ring reinforcer.
   c. The parent turns to the child, gets his or her attention, and models the vocalization while holding the star next to his or her mouth. The child imitates the model.
   d. All of the child's imitative attempts are praised and reinforced immediately. The clinician transcribes the child's response in the space provided on the score sheet.
   e. If the child's production is fully acceptable (receives 2 points), go to the next stimulus item and repeat steps 2a–d.
   f. If the child does not respond or the imitative response is not fully acceptable, note NR (no response) or transcribe the child's original attempt on the first line under the stimulus item.
      - Repeat steps 2a–d with the same stimulus to give the child a second chance. Transcribe and score the child's second attempt.
      - Only one repetition is allowed for each stimulus item.
      - The ring reinforcer is given even if the child does not respond.
   g. Continue introducing other stimulus items as in steps 2a–d until all the items at level 1 (precanonical) have been presented to the child.
   h. Present stimulus items for level 2 (basic canonical syllables) using the procedures in steps 2a–g.
   i. If the child scores at least 1 point on level 2, present stimulus items from level 3 (advanced forms) following steps 2a–g. Testing may be discontinued if the child does not receive any points on level 2 and the parent reports that the child rarely produces canonical (CV) syllables. If the child is reported to produce canonical syllables, present all stimulus items.

3. Scoring
   a. Scoring criteria are given on the score sheet.
   b. If more than one imitation is elicited, score only the most acceptable imitative response (i.e., the response with the highest score).
   c. Compare the child's productions with the parent/clinician's model. For example, an imitative production can be fully acceptable if it matches a model that was slightly different from the intended target (e.g., Mother says /kan/ instead of /kon/ and child says /kan/).
   d. Add up the number of points for the total score.

4. Repeat Testing

The CASP-S can be given at 2-, 3-, or 4-month intervals. Compare results with the previous scores for the same child.

Appendix B

The Conditioned Assessment of Speech Production - Spanish (CASP-S)

Alliete R. Alfano, Daniel Gonzalez, and David J. Ertmer

Child's Name_____ **DOB**_____ **CA**_____ **Date**_____

Parent_____ **Clinician**_____ **Sensory aid type**_____ **Months of sensory aid use**_____

Directions for parents: I am going to say some sounds for you to imitate. Then you will say the same sounds for your child to imitate. Try to say the sounds in the same way and at the same loudness level that I use. We will give (child's name) toys and praise for playing this game with us.

Instrucciones para los padres: Voy a decir algunos sonidos para que me imites. Después vas a decir esos mismos sonidos para que su hijo/a los imite. Intente decir los sonidos de la misma manera y volumen de voz que yo. Vamos a premiar y darle juguetes a (nombre del cliente) por jugar con nosotros este juego.

Warm-up Sounds:

/u/: Child imitates readily _____ Imitates after pause_____ No Response_____
/o/: Child imitates readily _____ Imitates after pause_____ No Response_____

Level 1: Precanonical Vocalizations

Stimuli for Models Transcribed Responses	0 points	1 point	2 points	Score
1. Prolonged central vowel in isolation: /a/ 1. _____ 2. _____	1. No response 2. Two or more vowels that do not match target 3. Response is not a vowel (e.g., squeal, raspberry, click, /m:/, /s:/) 4. CV syllable(s) without target vowel (e.g., /bu/)	1. Two or more vowels that match target 2. Single vowel that is not /ə/ 3. CV syllable containing target vowel (e.g., /ba/)	1. One central vowel (i.e., /a/)	
2. Two high-front vowels: (/i/ /i/) 1. _____ 2. _____	1. No response 2. Response is not a vowel 3. Syllables with vowels that do not match target (e.g., /bu/)	1. Single vowel that matches target 2. Two vowels that are not /i/ 3. Two vowels, only one of which matches the target (e.g., /i/ /ə/) 4, CV syllables containing target vowel (e.g., [bibi])	1. Two high front vowels (i.e., /i/)	
3. Three mid-front vowels: (/e/ /e/ /e/) 1. _____ 2. _____	1. No response 2. Response is not a vowel 3. Syllables with vowels that do not match target (e.g., /bu/)	1. Single /e/ 2. Two matching vowels (e.g., /e/ /e/) 3. Three vowels, only one /e/ 4. Two or three non-matching vowels (i.e., none are /e/) 5. CV syllables containing target vowel (e.g., [bebebe])	1. Three mid front vowels (i.e., /e/)	

Level 2: Basic Canonical Syllables

Stimuli for Models Transcribed Responses	0 points	1 point	2 points	Score
4. CV syllable with bilabial stop consonant: [ba] 1. _____ 2. _____	1. No response 2. Vowel without consonant	1. CV syllable in which only the C or the V match the model (e.g., [bi] or [ka]) 2. Two or more matching CVs (e.g., [bababa] or [papə]) 3. CVC syllable with matching C or V	1. A single CV with a bilabial stop consonant and /a/ or /ə/ (i.e., [pa], [bə], or [pə])	
5. CV syllable with bilabial nasal: [ma] 1. _____ 2. _____	1. No response 2. Vowel in isolation 3. Consonant in isolation	1. CV syllable in which only the C or the V match the model 2. Two or more matching CVs (e.g., [mamama] or [məmə]) 3. CVC syllable with matching C or V	1. A single CV with a bilabial nasal consonant and /a/ or /ə/ (i.e., [ma] or [mə])	
6. CV syllable with labiovelar glide: [wa] 1. _____ 2. _____	1. No response 2. Vowel in isolation 3. Consonant in isolation	1. CV syllable in which only the C or the V match the model 2. Two or more matching CVs (i.e., [wawawa] or [wəwə]) 3. CVC syllable with matching C or V	1. A single CV with a labiovelar glide /w/ and /a/ or /ə/ (i.e., [wa] or [wə])	
7. CV syllable with velar stop: [ka] 1. _____ 2. _____	1. No response 2. Vowel in isolation 3. Consonant in isolation	1. CV syllable in which only the C or the V match the model 2. Two or more matching CVs (i.e., [gagaga] or [kəkə])	1. A single CV with /k/ or /g/ and /a/ or /ə/ (i.e., [ka], [ga] or [kə], [gə])	
8. CV syllable with alveolar fricative: [sa] 1. _____ 2. _____	1. No response 2. Vowel in isolation 3. Consonant in isolation	1. CV syllable in which only the C or the V match the model 2. Two or more matching CVs (i.e., [səsəsə] or [zaza]) 3. CVC syllable with match C or V	1. A single CV with /s/ or /z/ and /a/ or /ə/ (i.e., [sa], [za] or [sə], [zə])	

Level 3: Advanced Forms

Stimuli for Models Transcribed Responses	0 points	1 point	2 points	Score
9. C + diphthong syllable: [naɪ] 1. _____ 2. _____	1. No response 2. Isolated vowel 3. Isolated C (e.g., /m/) 4. CV without a diphthong 5. Non-matching diphthong (e.g., /ui/)	1. Matching diphthong in isolation 2. /n/ + non-matching diphthong (e.g., [nɔɪ]) 3. Non-matching C with matching diphthong (e.g., [maɪ]) 4. /n/ plus vowel (e.g., [na]) 5. CVC syllable with /n/ and /aɪ/ (e.g., [naɪk])	1. /n/ plus matching diphthong (i.e., [naɪ])	
10. CVC: [kon] 1. _____ 2. _____	1. No response 2. Vowel in isolation 3. Isolated consonant (e.g., /s/) 4. VC or CV syllable	1. CVC syllable with non-matching Cs and V (e.g., [pip]) 2. CVC syllable with one or two segmental errors (e.g., [kop])	1. CVC syllable with initial /k/ or /g/ and final /n/ combined with /o/ or /a/ (e.g., [kon], [gon], [kan], [gan])	