Published in final edited form as:

Ear Hear. 2016 ; 37(4): 492–494. doi:10.1097/AUD.0000000000000279.

Testing speech recognition in Spanish-English bilingual children with the Computer Assisted Speech Perception Assessment (CASPA): Initial Report

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Abstract

Objectives—To evaluate the English version of Computer-Assisted Speech Perception Assessment (E-CASPA) with Spanish-English bilingual children. E-CASPA has been evaluated with monolingual English speakers 5 years and older, but it has not been examined in bilingual children.

Design—Eleven Spanish-English bilingual and 12 English monolingual children with normal hearing were tested using E-CASPA. Responses were scored by word, phoneme, consonant, and vowel.

Results—Performance was similar between bilingual and monolingual children.

Conclusions—The present results provide evidence that E-CASPA phoneme scores in bilingual children could be compared to monolingual peers.

Keywords

Computer Assisted Speech Perception Assessment; Spanish-English bilingual children

Introduction

Audiologists in the U.S. face a challenge when they need to evaluate speech recognition in patients whose first language is not English. While the Hispanic population represents more than 16% of the population in the United States (Humes et al. 2011), less than 2% of the audiologists in the U.S. are Spanish-English bilingual, suggesting a shortage of audiologists who may be able to assess, treat, and (re)habilitate hearing and balance disorders in both languages (ASHA 2014). Knowledge of more than one language is known to influence speech perception in noise even for bilingual adults (Rogers et al. 2006) who learned both languages early in life. Although attempts have been made (e.g., Calandruccio et al. 2014), currently there is no clinical tool normed to evaluate speech recognition in Spanish-English bilingual children.

The Computer-Assisted Speech Perception Assessment (CASPA; Boothroyd 2008a) is a computer program developed to evaluate speech perception reliably and efficiently. The latest version of CASPA includes stimulus materials recorded by two female talkers. Talker 1 was a monolingual speaker of American English, and Talker 2 was Spanish-English bilingual with near-native fluency in Southern California dialects in both languagesⁱ. Talker 2 recorded both English (E-CASPA) and Spanish words (Haro 2007). E-CASPA stimulus materials consist of 20 lists of ten consonant-vowel-consonant real words. Each list in E-CASPA contains the same set of 30 phonemes. Users can present the word lists at various signal levels with and without different levels of talker-specific speech-shaped noise, which results in varied signal-to-noise ratios (SNRs). Responses are scored online and summarized for each patient in percent-correct recognition of word, phoneme, consonant, and vowel. However, suggested clinical application focuses on phoneme score because it increases the number of data points, while maintaining the number of test items low (Gelfand 1998) and reduces the influence of linguistic knowledge (Boothroyd 2008b).

E-CASPA has been shown to reliably assess speech perception for English-speaking adults (Mackersie et al. 2001) and children as young as five years old (McCreery et al. 2010). Considering that phonological development of bilingual children is different from that of monolingual peers (Goldstein et al. 2005), separate E-CASPA norms may be needed even for early bilingual speakers.

This study evaluated performance on the E-CASPA with early Spanish-English bilingual children who have been exposed to English before their Spanish is fully developed. The goal was to determine whether bilingual and monolingual children differ in their E-CASPA scores.

Materials and Methods

Stimulus materials

Stimulus materials were English words provided in CASPA 5.0 (Boothroyd 2008a) (See manual for description of stimulus words). Only the recordings from a female bilingual speaker (Talker 2) were usedⁱⁱ.

Participants

Eleven 6 to 12 year-old typically-developing Spanish-English bilingual and 12 English monolingual children participated. All children had normal hearing (≤ 20 dB HL bilaterally at octave frequencies from 250 to 8000 Hz), age-appropriate articulation in English (Goldman-Fristoe Test of Articulation, Goldman & Fristoe 2000), normal intelligence (Test of Nonverbal Intelligence, Brown et al. 2010), and normal expressive vocabulary in English (Expressive Vocabulary Test, Williams 2007). All bilingual children were born in the USA.

ⁱThis is the only language background information about the bilingual talker provided in Haro (2007).

ⁱⁱThe initial goal of this study was to test both English and Spanish versions of CASPA with bilingual children. Talker 2 was chosen for the study to control for voice quality difference between English and Spanish words. However, unlike the results for E-CASPA, the results for the Spanish version suggested that the evaluation of various aspects of the Spanish version (e.g., word choice, impact of dialectal differences, etc.) require a larger dataset. Therefore, only the results for E-CASPA are reported here. Analysis on a larger dataset comparing English-Spanish bilingual children's performance on E-CASPA and Spanish CASPA is underway.

Spanish was the home language for most of the parents, while communication among siblings was mostly in English. Table 1 presents a summary of bilingual children's family background, language use, English vocabulary scores, and articulation errors.

Procedures

Participants were tested in a sound-attenuated booth. Stimuli were presented in a background of speech-shaped noise at 55 dB SPL, through a single loudspeaker (GSI-61). All participants heard four 10-word lists. Each list was randomly presented to each participant at one of four SNRs: 5, 0, -5, and -10 dB in a descending order to avoid discouraging children from listening if they were first presented with the lowest SNR. The first list, presented at 5 dB SNR was a practice list, and was not included in the analysis. Participants repeated each word as heard. Using the CASPA interface, the second author (who is a Spanish-English bilingual) entered the responses via keyboard. CASPA software provided whole-word, phoneme, consonant, and vowel percent-correct scores for each listener.

Results

Figure 1 presents consonant, phoneme, vowel, and word-percent-correct scores for bilingual and monolingual children at three SNRs. Percent-correct scores were converted into Rationalized Arcsine Units (Studebaker 1985) for statistical analyses: Four group x SNR ANOVA (one for each of the scores) were performed to compare performance of bilingual and monolingual groups.

The results showed that the main effect of SNR was significant for all the scores ($p < 0.001$). Tukey's HSD test indicated that for all scores, performance improved as SNR increased ($p < 0.001$). Neither the main effect of group nor the interaction between group and SNR was significant for any of the scores. These results show that: 1) the effect of SNR was similar for both bilingual and monolingual groups across all scores; 2) there were no differences in E-CASPA performance between monolingual and bilingual children whether responses were scored for word, phoneme, consonant or vowel.

Discussion

The goal of the present study was to determine whether a separate norm is necessary to assess speech recognition for Spanish-English bilingual children using E-CASPA. Normal-hearing English-speaking monolingual and early Spanish-English bilingual school-age children were compared on word, phoneme, consonant, and vowel recognition. The present results showed that, early bilingual children perform similarly to monolingual peers on E-CASPA.

The present results contrast with reports for early bilingual adults. For example, Rogers et al. (2006) found that bilingual adults (who had acquired English either from infancy or toddlerhood) performed more poorly than English monolingual listeners in recognizing English words in noise, suggesting a bilingual disadvantage. In contrast, results from this study show that early bilingual children (with similar onset age of learning English) did not

differ from their English-speaking monolingual peers. The present findings indicate that it is feasible to obtain E-CASPA phoneme score PI function for early Spanish-English bilingual children. Note that, although Spanish was the first language of the bilingual children in the present study, judging from the language use report, they are most likely dominant in English, a language profile most likely typical of second-generation immigrants in the U.S. This, in turn, suggests that monolingual English-speaking clinicians can assess speech recognition for bilingual children using E-CASPA. However, the present study did not include bilingual speakers with different first language or children who are more proficient in their first language. Therefore, it remains unknown whether the current results also apply to bilingual children with different first language or whether E-CASPA is appropriate to assess speech recognition in Spanish-English bilingual children with different levels of proficiency in English.

Lastly, as can be seen in Figure 1, phoneme score incorporates both consonant and vowel scores with consonant score contributing twice as much as vowel score. Also considering that vowels show dialectal difference (Labov et al. 2006) more than consonants, consonant score should provide reliable assessment results regardless of dialectal background of patients or clinician.

Acknowledgments

Financial Disclosures/Conflict of Interest:

This research was funded by NIH grants P20 GM109023, T35 DC008757, and P30 DC004662 awarded to Boys Town National Research Hospital. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References

- American Speech-Language-Hearing Association. Demographic profile of ASHA members providing bilingual services December 2014. 2014. Retrieved from <http://www.asha.org/uploadedFiles/Demographic-Profile-Bilingual-Spanish-Service-Members.pdf>
- Boothroyd, A. Computer-Assisted Speech Perception Assessment (CASPA) 5.0 Software. San Diego, CA.: 2008.
- Boothroyd A. The performance/intensity function: An underused resource. *Ear Hear.* 2008; 24:392–405.
- Brown; Sherbenou; Johnsen. Test of Nonverbal Intelligence, TONI-4. 4th ed.. PRO ED; Austin, TX.: 2010.
- Calandruccio L, Gomez B, Buss E, Leibold L. Development and preliminary evaluation of a pediatric Spanish-English speech perception task. *Am J Audiol.* 2014; 23:158–172. [PubMed: 24686915]
- Gelfand S. Optimizing the reliability of speech recognition scores. *J Sp Lang Hear Res.* 1998; 41:1088–1102.
- Goldman, R.; Fristoe, M. Goldman-Fristoe Test of Articulation. 2nd ed. (GFTA-2). Pearson Publishing; California: 2000.
- Goldstein B, Fabiano L, Washington P. Phonological skills in predominantly English-speaking, predominantly Spanish-speaking, and Spanish-English bilingual children. *Lang Sp Hear Serv Schls.* 2005; 36:201–218.
- Haro, N. Development and evaluation of the Spanish computer-assisted speech perception assessment test (CASPA). San Diego State University; San Diego: 2007. Unpublished AuD research thesis
- Humes, KR.; Jones, NA.; Ramirez, RR. Overview of race and Hispanic origin: 2010 (C2010BR-02). 2011. Retrieved from: <http://www.census.gov/prod/cen2010/briefs/c2010br-02.pdf>

- Labov, W.; Ash, S.; Boberg, C. Atlas of North American English: Phonology and Sound Change. Mouton/de Gruyter; Berlin: 2006.
- Mackersie CL, Boothroyd A, Minniear D. Evaluation of the Computer-Assisted Speech Perception Assessment test (CASPA). J Am Acad Audiol. 2001; 12:390–396. [PubMed: 11599873]
- McCreery R, Ito R, Spratford M, Lewis D, Hoover B, Stelmachowicz P. Performance-intensity functions for normal-hearing adults and children using computer-aided speech perception assessment. Ear Hear. 2010; 31:95–101. [PubMed: 19773658]
- Rogers C, Lister J, Febo D. Effects of bilingualism, noise, and reverberation on speech perception by listeners with normal hearing. Applied Linguistics. 2006; 27:465–485.
- Studebaker GA. A 'rationalized' arcsine transform. J. Speech Hear Res. 1985; 28:455–462. 1985. [PubMed: 4046587]
- Williams, K. Expressive Vocabulary Test -2nd ed. (EVT-2). Pearson; San Antonio, TX: 2007.

Figure 1. Average percent-correct word (upper left), phoneme (upper right), consonant (lower left), and vowel (lower right) scores for bilingual and monolingual groups at the three SNRs. Open and filled circles represent average scores for monolingual children and bilingual children, respectively. Error bars denote ± 1 SE.

Table 1
Language use, parents language background, and test scores information of bilingual participants.

Parents Language and Education Background										Language use			English Language Measures		
Subject age_ID	AoA		LoR		Educ		Occup		Home		Schl	Soc	GFTA-2 Errors	EVT Std Score	
	M	F	M	F	M	F	M	F	M	F	Sib				
6_1	NE	22	10	18	HS	HS	HW	MP	S	S	E	E	SE	s→z j→i v→b r→w th→f	93
6_2	NE	20	10	10	ES	HS	HW	MP	S	S	E	E	S	v→b s→z th→f z→s	87
7_1	25	30	11	11	B	ES	HW	Co	S	S	E	E	S	s→z	98
7_2	21	22	13	13	ES	MS	HW	Co	SE	SE	E	SE	SE		91
7_3	18	18	12	12	HS	HS	HW	Co	SE	SE	E	E	SE	z→s s→z th→d	89
8_1	Inf	18	31	18	HS	ES	HW	Ca	E	S	SE	E	E	s→z	112
8_2	18	22	22	-	HS	MS	HW	TD	S	S	E	E	E	v→b	102
9_1	37	NE	9	9	HS	ES	HW	Co	S	S	E	SE	S		90
10_1	Inf	18	31	18	HS	HS	HW	Ca	S	S	E	E	SE	s→z	94
11_1	NE	22	10	22	HS	HS	HW	MP	S	S	E	E	SE		118
12_1	21	22	13	13	ES	HS	HW	Co	S	S	E	SE	SE		85

AoA: Parents Age of Acquisition of English (in years), Infancy: started to learn English before age 1, No-Eng: Does not speak English, M: Mother, F: Father, Sib: Siblings, US: United States, LoR: Length of Residence in the US (in years), Educ: Education, ES: Elementary school, MS: Middle school, HS: High school, B: Bachelors, Occup: Occupation, HW: Housewife, MP: Meatpacking, Co: Construction, TD: Truck Driver, Ca: Carpenter, S: Spanish, E: English, SE: Spanish and English, Schl: School, Soc: Social, -: Information not available.