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Speech perception in bilingual speakers: Ten years of research

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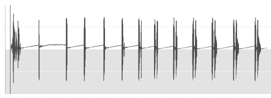
SPEECH PERCEPTION IN BILINGUAL SPEAKERS: TEN YEARS OF RESEARCH



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WHAT IS SPEECH PERCEPTION?

One must hear speech sounds (audition, hearing)

One must perceive what the sound is, process the information (speech perception), and

One must interpret the sound and identify the sound (speech perception).

Speech perception is more than just hearing sounds.

STUDY ONE.

Brice, A., Castellon-Perez, Y., & Ryalls, J. (2004). Speech recognition of code switched words by proficient Spanish-English bilinguals. *Journal of Distinguished Language Studies, 2*, 13- 22.

STATEMENT OF THE PROBLEM

It is important to know how bilingual speech input affects information processing in bilingual speakers. That is, do bilingual speakers use a top-down (sentences and context), bottom-up (sounds), or a combination of the two processing models.

This information is essential when applied to bilingual disordered subjects (e.g. adult aphasia patients or language delayed children) in order to clarify what type of language input will best facilitate learning and recovery of language abilities.

PURPOSE STATEMENT

The purpose of this investigation was to study recognition of code-switched words in speech among Spanish/English bilingual individuals.

HYPOTHESES

It was hypothesized that when fluent, Spanish-English speaking bilinguals are presented with an initial phoneme CC contrast with Spanish as the base language then there will be no difference in their perception and identification with no time difference lag demonstrating 100% confidence of an English code-switched word.

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METHODOLOGY

Subjects

Thirty Spanish/English fluent bilinguals with no reported speech or hearing deficits were used in this experiment.

Each participant was required to be a minimum of 18 years old and have lived in the U.S. for at least 6 years.

DESIGN

The two independent variables manipulated in this study were:

1. The two languages tested.

Spanish sentences with an English target code-switched word (1. Spanish as the base language and English as the guest word) and English sentences with a Spanish target code-switched word (2. English as the base language and Spanish as the guest word) as well as (3. English as the base language with a non-code switched English word, and 4. Spanish as the base language with a non-code switched Spanish word).

2. Phonotactic Structure (CC vs. CV).

Phonotactic Structure (CC vs. CV). There were 10 English and 10 Spanish words containing initial voiced and voiceless CC phonemes and 15 English and Spanish words with initial tense CV phonemes as well as 5 English words with initial lax CV phonemes.

These were chosen to determine if there would be a quicker reaction time in recognition of English and Spanish code-switched words. Initial CC clusters contained consonants (e.g. /br/, /fr/, /fl/, /gr/) that are seen in both the English and Spanish language. The CV words consisted of both tense and lax vowels.

GATING

In a gating task "…a spoken language stimulus is presented in segments of increasing duration and subjects are asked to propose the word being presented and to give a confidence rating after each segment" (Grosjean, 1996, p.597).

70 ms gates used in these studies as per Li (1996), a student of Grosjean.

GATING EXAMPLE

1. Get out a sheet of paper.
2. You will need to write down what you believe the word is that you hear at the end of the sentence and consequently what the word is.
3. Also, indicate if you are 100% sure of your word choice.
4. Do not share.

GATING

There has been increasing evidence that gating is very useful in assessing the amount of phonetic acoustic information needed for the correct identification of a word (Li, 1996).

It can be a potentially powerful paradigm in that it shows how the subjects (along with their confidence ratings) can reflect what is going on their minds (Grosjean, 1996).

Grosjean (1980) found that the point in the gating sequence (at which a word is identified correctly by the listener) is influenced by its frequency, its length, and the amount of prior context.

SUMMARY OF FINDINGS AND INTERPRETATIONS

It was hypothesized that when fluent, Spanish-English speaking bilinguals were presented with an initial phoneme CC contrast with Spanish and English as the base languages then there would be no difference in their perception and identification (i.e., with no time difference lag demonstrating 100% confidence) of an English or Spanish code-switched word.

The results of this study indicated that the bilingual listeners were not able to differentiate items with regard to the specific language being heard when the CC word was voiceless. The listeners were also not able to differentially perceive the phonotactic features of each language.

Certain features of the voiceless initial consonant did not aid their perception and identification of the Spanish and English items. It appeared that the bilingual listeners recognized each language equally, i.e., there were no significant time differences in recognizing the languages within the voiceless CC condition.

Bilingual listeners were able to differentiate items with regard to the specific language being heard when the initial CC word was voiced.

The listeners were able to differentially perceive the phonotactic features of each language thus aiding their word recognition.

The English word (i.e., initial CC that was voiced) was recognized quicker than the Spanish counterpart.

Possibilities for this may include the following explanations:

(a) Initial CC words that are voiced may be perceived quicker in English

(b) The participants were surrounded in a predominantly English environment, thus, their Spanish perception skills may be affected by less Spanish input.

(c)The majority of the participants showed a slight English dominance over their Spanish. Certain sounds in the CC clusters may have triggered recognition of the word being English.

The Spanish "trill" is very easily identified, thus, when the listener heard an /r/ sound that was not a "trill" the word had to be in English. Thus, the English /r/ versus the Spanish "trill" distinction may have aided the recognition. Further studies may wish to investigate the role of Spanish and English dominance in bilingual perception.

It was hypothesized that when fluent, Spanish-English speaking bilinguals were presented with an initial phoneme CV contrast, i.e., lax and tense vowels, with Spanish and English as the base languages then there would be no difference in their perception and identification with no time difference lag demonstrating 100% confidence of an English or Spanish code-switched word.

Bilingual listeners were able to differentiate items with regard to the specific language being heard when the initial CV word was tense. The listeners were able to differentially perceive the phonotactic features of each language thus aiding their word recognition with tense CV words.

The Spanish tense word was identified quicker than its English counterpart.

Possibilities for this may include:

(a) CV words with tense vowels may be perceived quicker in Spanish.

(b) Spanish vowels are more consistent in length and shorter in duration than English vowels (Brice & de la Paz, 1997; Terrel, 1989).

(c) Spanish vowels in the initial portion of the syllable tend to be tense (Brice & de la Paz, 1997), whereas, English may contain either tense or lax vowels in the initial CV position thereby influencing the participants' perceptions.

As previously mentioned, Spanish does not contain lax vowels in the initial CV positions, therefore, comparison of English and Spanish CVs containing lax vowels was not possible.

A comparison of English-only phontactic constructions were conducted.

Results of these comparisons indicated that CC1 (voiced) was significantly different from CV1 (tense vowel) and CV2 (lax vowel). In addition, CC2 (voiceless) was significant with CV1 (tense vowel) and CV2 (lax vowel). Thus, consonants were distinguishable from vowels in both consonant conditions.

The lax vowel in the CV cluster was recognized more quickly than the tense vowel production (lax vowels only in English). Since, Spanish does not have syllable initial lax vowels the subjects had to continue processing the information (i.e., was it English versus Spanish?) prior to making a decision when tense vowels were presented.

Tense vowels taking longer to process; elimination of one language with lax vowels -> faster processing.

IMPLICATIONS

Much of what is known about spoken word recognition comes from the research with monolingual individuals.

Limited research has examined the interaction of two languages being processed by bilingual listeners. Li (1996) stated that with Chinese-English bilinguals they kept both languages activated simultaneously, thus, supporting the notion of parallel activation.

These results also seem to support a combined manner of speech perception/recognition.

In addition, Li suggested that the perception and recognition process was interactive with phonotactic structures, language phonetics, and short versus long contexts. This study supports the notion of parallel activation. It also supports the notion of interactive processing within CC and CV comparisons.

This finding supports Li's (1994) previous work with Chinese-English bilinguals. It should be noted that Spanish-English bilinguals were used in this study, hence, similarities among languages (English and Spanish) does not seem to either enhance or negate the recognition process.

It may be suggested that balanced bilinguals seem to process and identify both languages in the same or near physiological region of the brain (e.g., supramarginal gyrus, angular gyrus, Wernicke's area, Broca's area, dorsolateral prefrontal cortex).

STUDY TWO

Brice, A., Chen, Y. Ryalls, J., & Ratusnik, D. (2004). Identification of code mixed words by fluent Taiwanese-English bilinguals. *Asia Pacific Journal of Speech, Language and Hearing, 9*(3), 232-249.

STATEMENT OF THE PROBLEM

Do bilingual speakers use a combination processing model (Grosjean, Dommergues, Cornu, Guillelmon, & Besson, 1994)?

The purpose of this investigation was to study:

1. The recognition of CM words among Taiwanese-English speaking bilingual individuals.
2. If there was a difference according to a participant's length of residence (LOR) in their perception of the code mixed stimuli?

It was hypothesized that balanced Taiwanese-English bilinguals maintain both languages active while processing bilingual input. This was measured using a gating task where the participants identified the word with complete confidence (100% confidence recognition of the word and language over 2 consecutive presentations or the total acceptance point).

It was hypothesized that subsequent length of residence would affect the speaker's overall language proficiency and consequently his/her speech perception of Taiwanese and English CM words under the four language conditions of: (a) English with Taiwanese, (b) English with English, (c) Taiwanese with English, and (d) Taiwanese with Taiwanese.

METHODOLOGY

PARTICIPANTS

32 Taiwanese-English fluent bilinguals. A minimum of 20 to 40 years of age. Lived in the U. S. for at least 3 years.

Being fluent in both the Taiwanese and English languages as determined by self-report and an oral language proficiency rating (i.e. the International Second Language Proficiency Rating ISLPR) administered by the examiner (Wylie & Ingram, 1999).

An accepted score of 3 or higher on the ISLPR in both languages was used (1= lowest, 5= highest)

DISCUSSION

Results indicated significant differences for the independent variable of language but not for group or the interaction of language and group.

Balanced bilingual participants were able to distinguish the different language conditions, i.e. the groups were balanced bilingual code mixers.

Tests of Within Subject Contrasts indicated that participants were able to perceive conditions of code mixing under both languages. This indicates balanced code mixing abilities.

Although no statistical significant differences were obtained for the group variable, evident differences did occur.

DESCRIPTIVE DIFFERENCES FOR GROUPS

An uneven performance profile under the four different language conditions

A slight trend towards a Taiwanese language preference.

Perceiving better in Taiwanese due to the differences in the two languages.

The possibility of not having been sufficiently immersed in an English environment.

The Long LOR group

Performed better under all language conditions.

Performance was followed by the Short and Middle LOR groups respectively

Have benefited the most from E. immersion since they performed the best

The Short LOR group

May have been able to transfer T. perceptual skills to E. as they performed similar to the Long LOR group under all 4 conditions.

The Middle LOR group

Has benefited the least from E. language transference (note the E. with E. language condition)

Has not been able to benefit from their E. exposure to the same extent as the Long LOR group

Hence, it appears that <u>no one-to-one correspondence exists between LOR (i.e., increased English exposure) and E. perceptual proficiency</u>.

IMPLICATIONS

This study supports the notion of Parallel Activation given that participants demonstrated the ability to distinguish the different language conditions

Length of residence does not seem to "significantly" impact a balanced bilingual's perception of one language vs. the other. However, LOR had observable effects upon the participants' speech perception.

STUDIES THREE AND FOUR

Brice, A. & Brice, R. (2008). Examination of the critical period hypothesis and ultimate attainment among Spanish-English bilinguals and English-speaking monolinguals. A*sia Pacific Journal of Speech, Language and Hearing, 11*(3*)*, 143-160.

This study asks the following research questions:

(a) What establishes whether a word will be identified correctly according to phonotactic conditions (i.e., within group comparisons)?;

(b) What establishes whether a word will be identified correctly according to the participants' age of arrival (i.e., between group comparisons)?

(c) How do these factors work together in the recognition process (i.e., interaction of variables)?

In essence, this study is a measure of L2 proficiency for speech perception for three groups of fluent and proficient bilingual Spanish-English bilinguals based on both phonotactic features and AOA thus assessing the critical period hypothesis (CPH).

CPH states that an age effect takes place around puberty when (1) language learning decreases; and, (2) this decrease is exemplified by a severe cut-off slope.

METHODS
PARTICIPANTS

45 Spanish-English fluent bilinguals.

Between 18 – 40 years of age.

Having lived in the United States for at least 6 years.

Being fluent in both Spanish and English was a prerequisite determined by self-report and results of an oral language proficiency rating [International Second Language Proficiency Ratings, (Wylie & Ingram, 1999) ISLPR].

Rating scale was scored by a balanced Spanish-English bilingual speaker.

DISCUSSION
SUMMARY OF FINDINGS AND INTERPRETATIONS

Significant differences were found according to the different Phonotactic constructions. The Spanish-English bilingual listeners were able to differentiate words when the initial consonant English cluster was voiced.

Effect size for Phonotactic Comparisons was large, indicating a large degree of shared variance and the magnitude of this significance.

The English CC-voiced stimuli was recognized quicker than the Spanish CC-voiced (English 69.91 ms vs. Spanish 81.42 ms).

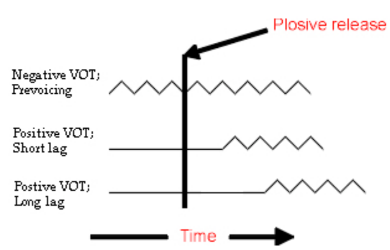
The participants in this study lived in the United States and attended an English speaking university, therefore, they are primarily surrounded by English in their environment.

Their Spanish speech perceptions skills may have been affected by lesser Spanish input.

Further study where participants are surrounded more by Spanish input should be investigated.

It appeared that the participants were better able to distinguish strong contrasts with regards to voice onset time (VOT) (i.e., prevoicing vs. short lags or across the plosive release time boundary) versus weaker VOT contrasts (i.e., short vs. long lags or within the release time boundary).   See Illustration.

VOT IMAGE



Voiced consonants are produced with prevoicing in Spanish and a short lag in English, whereas, voiceless consonants are produced with a short lag in Spanish and a longer lag in English (Brice, Castellon-Perez, & Ryalls, 2004; Flege & Efting, 1988; Lisker & Abramson, 1964; Zampini, 1998).

In addition, certain sounds in English may have triggered a word being identified in English. For example, the English liquid /ɹ / is different from the Spanish tap /r/ or the Spanish trill /R/.

CV-tense words were identified quicker in Spanish than in English. Spanish vowels are more distinct than English due to a more restricted set of vowels than English (Brice, Goldstein, Anderson, & So, 1996; Goldstein, 2001).

Spanish vowels are more consistent in length and are typically shorter in duration.

In addition, Spanish vowels are always tense. Therefore, these contrasts between Spanish and English vowels may have aided quicker identification in Spanish.

The results indicated significant differences between the AOA groups, i.e., between subject contrasts indicated differences for CC-voiced by the middle AOA group. In addition, differences were found between the middle and late AOA groups.

The middle AOA group (9-15) had the quickest identification times followed by the early (3-8) and late (16-22) AOA groups. Therefore, these results do not support the CPH.

The balanced bilingual middle AOA group benefited from having at least six years exposure and use in English and Spanish and at least 9 years of Spanish. Hence, it appears that language learning occurs best when each language is sufficiently supported; Cummin's second threshold hypothesis (1984).

This finding seems to suggest positive transference between the two languages at the speech perceptual level. However, the late AOA group performed the slowest in word identification. Therefore, a sensitive period or window of optimal learning may be present with the late bilinguals.

IMPLICATIONS

Certain Phonotactic features are independent to perception in each language. Other features may be interdependent. Balanced bilinguals in this study did not appear to have difficulty in identifying words in each language when simultaneously exposed to both languages.

AOA had observable effects upon the participants' speech perception.

Lenneberg's Critical Period Hypothesis (CPH) was not supported as indicated by the the best performance by the middle group.

STUDY FIVE

Brice, A., Gorman, B., & Leung, C. (2013). Spanish-English speech perception in children and adults: Developmental trends. *Clinical Linguistics and Phonetics,27*(3) 220-234*, d*oi: 10.3109/02699206.2012.757805

Specifically, there were two main objectives of this study:

To examine bilinguals' speech perception skills according to phonotactic construction (CCV+ voiced; CCV− voiceless; CV tense; CV lax), age group (child vs. adult) and language (Spanish, English).

To examine the potential developmental trends in the subgroup of child participants by analyzing whether there were any performance differences in speech perception by grade level (3rd, 4th and 5th grade).

PARTICIPANTS

Thirty fluent Spanish–English bilinguals with no reported history of speech, language or hearing disorders participated in this study. They included 15 children between 8 and 11 years of age, and 15 adults ranging from 18 to 40 years of age.

Addressing our first research question, results did indeed indicate significant differences of the entire groups of bilingual participants according to the different phonotactic constructions.

Both the Spanish–English children and adult listeners appeared to identify words fastest when their initial consonants were voiceless (i.e. CCV−voiceless), indicating that the voiceless feature facilitated their speech recognition. (contrary to previous results; did the children acquiring speech sounds affect this outcome? Voice-less sounds are developmentally easier to recognize).

The participants were living in the US and attended English speaking schools (i.e. elementary schools or university). Therefore, it is possible that their frequent exposure to both spoken and written English may account for their faster recognition of English CCV−voice-less words than Spanish CCV− voiceless words.

With regard to the second research question, it was asked if developmental differences in bilingual word identification skills in children at various grade levels would be found. No significant group differences were found between the children and the adults.

However, it should be noted that the children took longer to perceive words under all phonotactic constructions when compared with adults. These results seem to indicate a developmental learning trend.

However, when analyzed separately, phonotactic constructions were found to be significant indicating some developmental trends in Spanish for the third, fourth and fifth grade children.

The children across all grade levels recognized the English CCV+ voiced consonants faster than the Spanish CCV+ voiced consonants.

Students are exposed to more English in the school environment than Spanish in the home. Exposure issue.

Recognition of English voiced consonants may have also been due to the functional load (i.e. how often the sound occurs in word positions) and phonetic frequency of consonants (i.e. how often the sound occurs in spoken language) in each language, as English has more voiced consonants than Spanish (Ingram, 2011; Stockwell & Bowen, 1965). Characteristics of the language issue.

The English CCV− voiceless consonant words were recognized faster than the Spanish CCV− voiceless consonant words.

Again, exposure, functional loads and frequency of sounds may have affected outcomes.

For Spanish CCV− voiceless words, it was found that faster recognition occurred for the fifth grade students followed by fourth grade and then third grade students, suggesting a developmental learning trend. Developmental trends seemed to occur when comparing: (a) recognition of voiceless consonants to voiced consonants (e.g. [p] sounds are developmentally easier than [b] sounds) and (b) the child subgroups (3rd vs. 4th vs. 5th grade students with differences on the CCV+ voiced and CCV− voiceless consonant words).

Some students had difficulty differentiating between CCV− voice-less consonants vs. CCV+ voiced consonants, particularly the /p/ vs. /b/ distinctions in the Spanish words “plata” and “problema” (i.e. perceiving the words as “blata” and “broblema”).

Spanish speaking students had difficulty discerning short lags in /p/ vs. the sometimes prevoiced or short lag of /b/ (Brice & Brice, 2008).

Language abilities in bilinguals appear to be one that varies according to language and specific task.

WHAT’S NEXT? (BRICE & SALNAITIS)

COMING TO A LAB NEAR YOU!

Statement of the Problem

- It is crucial to diagnose and treat mild and moderate types of mild TBI including Blast induced neuro-traumas (BINT).
- A better identification tool and procedure is required.
- Language and cognitive abilities in L1-L2 speakers may be affected differentially according to language abilities; consequently, identification of L1 language and cognitive abilities vs. L2 language and cognitive abilities and localization may lead to enhanced understanding of TBI, increased diagnosis, and eventual better treatment of TBI.

Study bilingual, monolingual individuals with mild Traumatic Brain Injury (mTBI) utilizing:

- Gating speech perception methodology
- Functional near-infrared spectroscopy (fNIRS)

QUESTIONS?

Thank you.