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Cross-Modal Distraction on Simultaneous Translation: Language Interference in Spanish-English Bilinguals

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Cross-Modal Distraction on Simultaneous Translation: Language Interference in Spanish-English Bilinguals

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ABSTRACT: Bilingualism has been studied extensively in multiple disciplines, yet we are still unsure how exactly bilinguals think. Though the existence of a bilingual advantage is debated, this effect has been shown in tasks using selective attention. These tasks study the effects of language interference, where two types of interference are observed: interlingual (between-languages) and intralingual (within one language). This study examines language interference in Spanish-English bilinguals using an auditory-visual simultaneous translation experimental setup. Sixteen college English monolinguals and 17 college Spanish-English bilinguals were tested. Participants translated or repeated words displayed on a screen while ignoring distractor words played through headphones. Subjects were given 72 randomized words to translate while ignoring the distractor words played through either the left, right, or both ears. The monolingual group was not affected by any independent variables tested except the length of the word on screen. Bilinguals performed worse when the word and audio were in Spanish and when the word and audio were different words. No ear advantage was observed in either group. More intralingual interference was observed for bilinguals only, and no significant interference occurred for monolinguals. A slight bilingual advantage was found, but due to the high load of the task and introduction of another language, this advantage did not result in faster or better performance. Bilingual discourse would benefit greatly from further research investigating these effects in other language pairs.

KEYWORDS: bilingualism; bilingual advantage; language interference

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INTRODUCTION

Bilingualism is a popular area of study in neuroscience, the results of which better inform our understanding of the psychology of language. But how does bilingual cognition shape our mental processing? The existence of a "bilingual advantage" is widely debated. If such an advantage exits, benefits of learning a second language could push educational curriculum to adopt language acquisition courses earlier on. This change would also promote cultural inclusion and inter-societal exchange, diminishing language barriers and biases.

Literature Review

The Stroop task (1935) is one method for testing how bilingual persons process words in both languages. In a Stroop task participants are shown words in colored ink and are asked to say the color of the word. Either the word matches the colored ink name, e.g. "blue" written in blue (termed congruent) or does not match, e.g. "blue" written in red ink (incongruent). The Stroop task can be modified to test bilinguals by switching the language of the word or ink. This competing urge to say the word rather than color is called "interference". We are taught to read words, and the color they are printed in is merely a detail. With this task, participants are asked to do the opposite: to suppress the innate processing of reading the word. Interference is a competition of processing between two sets of information. For example, when you are in a crowded restaurant, you must selectively tune out other conversations to hear the server or the person you are with. In the context of a bilingual Stroop task, the incongruent condition produces interlingual interference while the congruent condition produces intralingual interference. Intralingual means within one language, while interlingual means between two languages. There is a substantial amount of research applying the Stroop task to bilinguals, the earliest dating from the 1960's[1].

The crucial part of these experiments is the measurement of interlingual and intralingual interference, quantified by comparing reaction times in the various conditions. The consensus is that intralingual interference is higher than interlingual interference (Dyer, 1970; MacLeod, 1991; Preston, 1965). The reason is explained by Brauer (1998):

> ...bilinguals store words of different languages in different language dictionaries. When only one language is involved, the stimulus is highly compatible with the response and can exert more interference than in the between-language conditions, in which the interference has to spread from one dictionary to another. (318).

Intra/interlingual interference is multi-factorial, with the most significant factor being language proficiency. Mägiste (1984) found that the dominant language creates a higher level of intralingual interference than interlingual[2], implying that your ability to filter out the second language becomes harder as you become more proficient. Similarity of the competing language plays a role as well, with closely-related languages, i.e. English and Spanish (sharing the same alphabet) would create higher interference than Arabic and English (Chen & Ho, 1986). These bilingual Stroop results have been a pivotal part of investigating language processing.

Another method of producing language interference in bilinguals is the dichotic listening task. A dichotic listening task measures how auditory language stimuli interferes with verbal language by having bilinguals translate simultaneously. Subjects are given a pair of headphones in which the stimulus is played in one ear, either with silence (control) or with distractor words playing in the other. The goal is to selectively focus on the ear (indicated by the researcher) that plays the target words. Bilinguals however, must simultaneously translate the word with an English or Spanish distractor word playing in the other ear (or silence for control). For example, a participant is instructed to only repeat what they hear in the left ear and to ignore the right ear, responding in English. The left headphone says "bar" and the right says "fish", the correct response being "bar". Choosing phonetically similar words would increase difficulty (e.g., "bar" and "car"). This choice would cause intralingual interference because all words are in English. Any error in response would be due to the distraction of English coming from the right ear. Interlingual interference would occur upon introduction of another language.

Soveri, Laine, Hämäläinen, and Hugdahl (2011) found that bilinguals are better at filtering out irrelevant stimuli than monolinguals, as they can suppress the unused language when speaking. Bilinguals only channel one language and can easily ignore the inactivated language. The bilingual advantage is described as better performance in executive tasks (e.g., dichotic listening) due to a higher level of cognitive functioning. This advantage is explained by Desjardins and Fernandez

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(2017): "The regular use of two languages requires that bilinguals control their attention and select the target language, which, in turn, is reflected in greater cognitive control on tasks with distracting information". The term "regular use" in that conclusion points out a limitation in the finding: bilinguals with less regular use of both languages might not have the same level, if at all, of greater cognitive control. There is no consensus on whether a bilingual advantage exists.

Few researchers have looked at the bilingual dichotic auditory task through the lens of inter/intralingual interference. Two papers analyzing the bilingual dichotic listening task in terms of interlingual and intralingual interference include Edith Mägiste (1984) and Everdina Lawson (1967). Lawson found that no switching of attention to the distractor stimuli occurred during the experiment, due to the high mental load of the task, leading to subjects being unaffected by the distractor stimuli. Fewer errors were made when the language of the distractor channel was the same as the target language of the translation. This result implies that distracting language has some effect on accuracy of translations; otherwise the level of errors would remain constant through all trials. Lawson also suggested this study be reproduced with more subjects, as her sample size was only six educated males.

Mägiste performed two experiments: a bilingual Stroop task and a bilingual dichotic listening task. In the listening task, intralingual interference was higher than interlingual, but not as high as in the Stroop task. The results also showed that higher fluency in the language allowed subjects to ignore the distractor stimuli, the same result that Soveri observed in her dichotic listening task (Mägiste, 1984; Soveri et al., 2011). A monolingual group illustrates differences between groups and can confirm or deny a bilingual advantage. Neither Lawson nor Mägiste did randomized which ear the participant translated from. Participants exclusively translated either the left ear or right ear without switching during the experiment. This method can easily lead to better performance due to practice, or right/left ear advantage. In addition, both researchers only measured responses in terms of errors. By contrast, I randomized the translated ear within subjects, including right, left, and both-ear stimuli. I also measured data based on accuracy (errors) and reaction times in milliseconds, recorded from a serial-response box. Though Mägiste's procedure used sentences for translation and, Lawson used passages from a book for translations, I used a one-word setup to limit extraneous variables affecting reading comprehension.

The proposed experimental setup of this research would be a novel way of evaluating language interference in bilinguals and a new addition into the scope of bilingual psycholinguistics. The cross-modal setup, chosen based on simplicity and novelty to the research discourse, acts as a combination of the Stroop and dichotic listening tasks. Presenting a visual target word on the screen and an auditory distraction word in the headphones was a setup based on existing literature suggesting that background speech or vocal music has a negative effect on cognitive performance in tasks with visual verbal material (Cauchard, Cane & Weger, 2012; Hughes et al., 2011; Pool, Koolstra, & van der Voort, 2003; Salamé & Baddeley, 1989). In summary, the process of speech gains access to the short-term storage of the phonological aspects of visual information, allowing the distractor speech to cause interference in the cognitive task (Salamé & Baddeley, 1989). Pool et al. (2003) describe this effect as a result of limited resources; the dual information might breach the capacity of cognitive resources, leading to only one source being processed (limited-capacity theory). Competition of dual modalities (visual and auditory) for resources leads to decreased performance in working memory cognitive tasks. As the proposed task contains visual information along with distracting auditory information, the distractor speech may negatively affect the subject's performance.

Experimental tasks that include words are highly susceptible to the frequency effect, defined as the recognition of higher frequency words (more common words) more easily or quickly than that of low frequency words (Howes & Solomon cited in Harley, 2001, p.158). The more you use or see a word, the more common it will become in your vocabulary, increasing its frequency and thus leading to faster recognition and retrieval. The age at which you first learn the word (age-of-acquisition) determines frequency level as well, with words learned earlier in life being recognized faster than those learned later in life (Harley, 2001, p. 158). Basic words are learned first and are thus used more regularly and for a longer period of time than specialized language gained later in life (i.e., contemporary). More common words are also shorter and take less time to say than longer words (Harley, 2001, p. 160), meaning that reaction times could possibly be faster for shorter words, with frequency affecting this as well. Recognition is faster with low frequency words that have a large neighborhood (Andrews, 1989; Grainger, 1990; McCann & Besner, 1987 cited in Harley, 2001,

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p.160). Neighbor words are phonetically similar and have one or two letter differences (i.e., dog and fog). A trial with visual and auditory neighbor words would create the most interference because the word would activate similar dictionaries and compete for processing. Word frequency, length, and phonetics were thus evaluated as independent variables in my data analysis.

The primary purpose of this study is to test the extent of inter and intralingual interference in a cross-modal audio-visual simultaneous translation task in Spanish-English bilinguals. The secondary purpose is to determine if a bilingual advantage occurs in this task. A bilingual advantage comes with uncertainty, as it is observed in some experimental settings but not others. I will test the following hypotheses:

Hypothesis 1: Bilinguals will produce less interference than monolinguals.
Hypothesis 2: Less proficient bilinguals will produce more interference than higher proficient bilinguals.
Hypothesis 3: Bilinguals will produce more intralingual interference.
Hypothesis 4: Phonetically similar words will produce more interference.
Hypothesis 5: Frequency effect will be observed in both groups.

METHODS

Participants

Sixteen Spanish-English bilinguals, and 17 English monolinguals were studied. All subjects had normal cognitive functioning and no auditory, visual, or physical impairments. Three out of the 33 participants were left-handed, and 30 were right-handed. All participants were recruited from the University of Central Florida using the psychology recruitment website SONA. All participants received one SONA participation credit. Age for the 33 participants ranged from 18-30, with bilingual averaging 20.25 years (SD = 3.73), and monolinguals averaging 18.64 years (SD = 1.32), while 51.51% of the participants were male. Half of bilinguals listed Spanish as their first language, 25% listed English, and 25% stated they learned both languages at the same time.

Materials

All subjects were given a consent form and a general questionnaire, consisting of background information, handedness, caffeine intake, studying habits, and music listening tendencies. Bilinguals were given English and Spanish proficiency tests as well as self-reported language fluency/acquisition questions. It was stated to select the most grammatically correct answer, in order to decrease the effect of varying dialects. Words from most commonly-used Spanish and English compilation websites were presented. Spoken forms of the words were recorded in both Spanish and English. Word recordings panned either 100% to the right ear, 100% to the left ear, or 50% left and 50% right (both ears). All recordings were less than a second long, said by the same speaker, and spoken neutrally. The speaker was a 21-year-old male native-born Puerto Rican, fluent in Spanish. There were two main conditions of stimuli for both groups: match (control) and mismatch (experimental). For the control, the word on the screen was the same as the word spoken in the headphones. In the experimental condition, the word on screen was different than the word spoken. In the monolingual group, both the words on the screen and the spoken words were always in English. The bilingual group consisted of four conditions: English on screen with English in headphones, English on screen with Spanish in headphones, Spanish on screen with Spanish in headphones, and Spanish on screen with English in headphones. Word relationship to audio panning were matched based on length of the words.

Procedure

The study was available in-person only and took place at UCF in the psychology building. Participants were given a general explanation of the experiment and voluntarily signed up for a specific time slot via the SONA website. In the lab they were given a packet containing the consent form, pre-survey, proficiency tests for English and Spanish (for bilinguals only), and a summary of the experiment. The task was explained by the researcher but was more detailed on the welcome screen before the start of the experiment. Participants were given these verbal instructions: "You are going to translate or repeat what you see on the screen while ignoring what you hear in the headphones. Use this button (1st button on the serial-response box, labeled '1') to continue to the next word. Read the instructions on the screen before starting". Bilingual participants were also given the instruction to "translate everything you see into English". Participants sat at a desk with the computer at eye level and at least 12 inches from their faces; a black trifold board was placed behind the computer to minimize distractions during the task. Subjects then put on the headphones, read the

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instructions and began. Monolinguals were instructed to repeat the word on the screen while ignoring the words spoken in either or both ears. Bilinguals were instructed to translate the word seen on the screen (English or Spanish) into English, while ignoring the spoken words (English or Spanish) in the headphones. To control for any ear advantage, the audio was panned randomly between left, right, and both channels. The word was presented in the middle of the screen for 1400 milliseconds, followed by a centered fixation cross. Participants pressed the first button on the serial-response box to continue onto the next word. Each participant saw 72 words. Word order was randomized and the two groups received different lists, since the monolinguals cannot translate Spanish words. The serial-response box recorded reaction times in milliseconds while the computer software recorded their translations/responses. Subjects were given a brief post-task survey asking how the task went, how they felt, and any feedback.

RESULTS

There were three groups of participants: all subjects, monolinguals, and bilinguals; the data for each group were analyzed separately. One-way analysis of variance (ANOVA) was conducted for every independent variable. Tests were done at a 95% confidence interval and found to be significant at the $p < 0.05$ level. Trial 1 was excluded from analysis due to software issues and participants forgetting to press 1 to advance. The control (match) condition was used in analysis because both groups were affected differently. An accuracy score of 1 means no errors were made, resulting in a 100% accuracy response. For example, means equaling 0.98 have an accuracy of 98%, and a higher accuracy score than 0.87. For reaction times, the lower the time (in milliseconds), the faster subjects were to respond. Performance was measured by number of errors (accuracy) and latencies (reaction times). More interference is defined as slower reaction times and lower accuracies.

All Subjects

There were three left-handed subjects (2 bilinguals, 1 monolingual), with handedness having no significant effect on accuracy nor reaction time. Neither caffeine nor gender had an influence on performance. Trial number was significant for both accuracy $F(70, 2272) = 1.51$, $p = 0.005$, and reaction time $F(70, 2272) = 2.39$, $p < 0.01$. Four variables from the music tendency questionnaire were tested for influence on performance: frequency of music played when studying, perceived loudness of the music, perceived effects of the music on concentration levels, and if music helped or hurt studying performance. None of these variables had any significant effect on performance. However, there was a significant difference between the performance of bilinguals and monolinguals for both accuracy $F(1, 2341) = 36.55$, $p < 0.0001$, and reaction time $F(1, 2341) = 40.79$, $p < 0.0001$. These differences are shown in Figures 1 and 2 below.

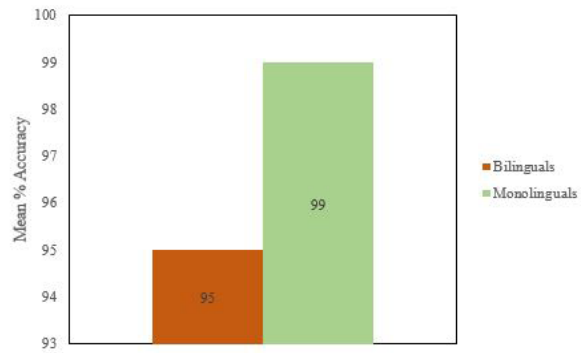

Figure 1: Average % accuracies for both groups, including all conditions.
Note. *Monolinguals* (M = 0.99, SD = 0.10); *Bilinguals* (M = 0.95, SD = 0.22).

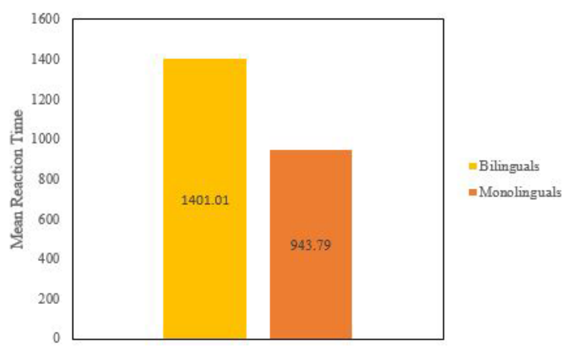

Figure 2: Average reaction times for both groups, including all conditions.
Note. *Monolinguals* (M = 943.79, SD = 1560.54); *Bilinguals* (M = 1404.01, *SD* = 1897.13).

All Subjects

Effects of the two conditions (match or mismatch), ear of the distractor stimuli, and whether the auditory distractor word went to both ears or an individual ear had no significant effects on accuracy or reaction time. Regarding the linguistic side of the experimental setup,

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four variables were tested for effects on performance: frequency of the screen word, frequency of the audio word, length of the screen word, and length of the audio word. Frequency of the screen or audio word had no significant results for accuracy nor reaction time. Length of screen word had a significant effect on accuracy only F(5, 1201) = 2.61, p = 0.024. A negative correlation was found between accuracy and length of screen word: the longer the word, the lower the accuracy became. Minimum word length was 2 letters (M = 1.00, SD = 0.00), and maximum word length was 7 letters (M = 0.96, SD = 0.20). Neither the length of audio word nor phonetically similar words yielded significant effects on participant's performance.

Bilinguals

Two variables from the background section of the survey were tested using an ANOVA: proficiency level and first language. Self-proficiency level questions were asked, and the results of the proficiency tests were graded. If a subject correctly responded to more than 50% of questions in any section then they were said to be proficient in that language. There were five levels of scoring for Spanish and three levels of proficiency for English. All subjects scored as highly proficient in the English section. Only five of the 16 bilinguals scored highly proficient in Spanish, while 11 of the 16 self-reported they were highly proficient in Spanish. The questions were based on grammar, and the most appropriate and grammatically correct was considered correct. Half of subjects listed Spanish as their first language, 4/16 listed English, and 4/16 listed both.

Whether the auditory distractor word went to both ears or an individual ear had a significant difference for accuracy only $F(1,1134) = 10.96$, $p = 0.001$, with accuracy rates higher for both ear stimuli ($M = 0.96$, $SD = 0.19$) than an individual ear ($M = 0.92$, $SD = 0.27$). The language of the target word on the screen yielded significance for accuracy $F(1, 1134) = 26.66$, $p < 0.01$, and reaction time $F(1, 1134) = 4.72$, $p = 0.03$. Accuracy was higher when the word on screen was in English ($M = 0.98$, $SD = 0.13$) than Spanish ($M = 0.92$, $SD = 0.28$), and reaction time was lower for English words ($M = 1278.65$, $SD = 1914.046$) than Spanish words ($M = 1522.93$, $SD = 1873.85$). The language of the auditory distractor word had a significant influence on accuracy only $F(1, 1134) = 10.45$, $p = 0.01$. More errors occurred when the language was Spanish ($M = 0.93$, $SD = 0.26$) than English ($M = 0.97$, $SD = 0.17$). The relationship between the word on screen and the audio word had a significant effect on accuracy only $F(1, 1134) = 7.23$, $p = 0.007$, with more errors in the experimental (mismatch) condition ($M = 0.93$, $SD = 0.25$) than the control (match) condition ($M = 0.97$, $SD = 0.18$). The ear to which the distractor word arrived had a significant effect on accuracy $F(2, 1133) = 6.28$, $p = 0.002$, with both ears having the highest accuracy ($M = 0.96$, $SD = 0.19$) and the left ear having a higher accuracy ($M = 0.93$, $SD = 0.25$) than the right ($M = 0.90$, $SD = 0.30$). A post-hoc test of least significant difference (LSD) was computed for the ear variable, with the results listed in Table 1.

Table 1: LSD Results for Ear x Accuracy One-Way ANOVA Test

D.V.	I	J	MD	SE	P
Accuracy	1	2	0.03	0.02	0.207
		3	-0.03	0.02	0.074
	2	1	-0.03	0.02	0.207
		3	-0.06*	0.02	0.001*
	3	1	0.03	0.02	0.074
		2	0.06*	0.02	0.001*

*p < 0.05

Note. The only significant comparison 2 (right ear) versus 3 (both ears).

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The condition of the word and distractor stimuli had significant effects on the accuracy of the participants ($F(3, 1132) = 10.10$, $p < 0.0001$). Conditions are listed in the format (screen word language, auditory word language). The highest accuracy was in the second condition (E, S) with (M = 0.99, SD = 0.08); condition 4 (S,S) produced the most errors (M = 0.91, SD = 0.29). The first condition (E, E) had (a mean accuracy of 0.98, and a standard deviation of 0.14), and the third condition (S, E) had (a mean accuracy of 0.94, and a standard deviation of 0.23). This variable was also significant for reaction time in the LSD posttest for condition 1 (E, E) versus 4 (S, S) only (MD = -261.63, SE = 129.86, p = 0.044), even though ANOVA reaction time was not significant.

Table 2: LSD Test for Condition x Accuracy One-Way ANOVA Test

D.V.	I	J	MD	SE	P
Accuracy	*1*	2	-0.01	0.02	0.503
		3	0.04	0.02	0.096
		4	0.07*	0.02	0.000**
	2	1	0.01	0.02	0.503
		3	0.05	0.03	0.057
		4	0.09*	0.02	0.000**
	3	1	-0.04	0.02	0.096
		2	-0.05	0.03	0.057
		4	0.04	0.02	0.077
	4	*1*	-0.07*	0.02	0.000**
		2	-0.09*	0.02	0.000**
		3	-0.04	0.02	0.077

*$p < 0.05$
**$p < 0.01$
Note. Only significant differences are 4 (S, S) versus 1 (E, E), and 4 (S, S) versus 2 (E, S)

The same four variables tested for monolinguals were tested for effects on performance in bilinguals. Unlike the monolingual participants, screen word frequency had significant effects on accuracy $F(35, 1100) = 2.38$, $p < 0.01$, and audio word frequency on accuracy F(68, 1067) = 1.64, $p = 0.01$. The screen words "pasa" (M = 0.75, SD = 0.44), "tiene" (M = 0.83, SD = 0.39), and "eres" (M = 0.86, SD = 0.35) had the lowest accuracy scores. A positive correlation was observed, with higher frequency words having a higher accuracy score. The audio words "quiero" (M = 0.75, SD = 0.45), "pasa" (M = 0.75, SD = 0.45), "casa" (M = 0.75, SD = 0.45) had the lowest accuracy scores. Reaction times for both frequency of screen word and frequency of audio word were not significant. The relationship between the length of screen word and reaction time was not significant, nor was the relationship between length of screen word and accuracy. The length of audio word was also not found to be significant in its relationship to accuracy, nor with reaction time. Four phonetic conditions were named: not phonetically similar, phonetically similar, phonetically similar with same word but audio word in English, and phonetically similar with same word but audio word in Spanish. Phonetic conditions had no significant influence on subjects' accuracy scores nor reaction times. Yet an LSD test for Phonetic type and Accuracy indicated a significant difference between phonetically similar (M = 0.91, SD = 0.22) and phonetically similar with same word but audio word in Spanish (M = 1.00, SD = 0.00), (MD = - 0.09, SE = 0.05, p = 0.052).

DISCUSSION

As the trials went on, all participants had higher accuracies and faster reaction times, as they had more practice. There were no significant differences in performance between male and female participants, nor any differences based on caffeine consumption, and having three left-handed participants did not impact the data. None of the music tendency variables returned significant results. Whether the participants listened to music while studying made no difference in their performance at this task. This result suggests there is no advantage to students who listen to music while studying, even at a high volume.

The purpose of the monolingual group was to act as a control group to see the effects of adding another language. This choice also allowed us to investigate if a bilingual advantage existed. Small sample size of participants can be a contributing confounding variable to the results. Monolinguals did not display interference by any of the variables tested except for screen word length. Having an auditory distractor word in any of the headphone ears did not seem to affect output performance. However, the length of the word on the screen did influence on their accuracy scores: the longer the word, the more errors the monolinguals made. A hypothesis for this result is that

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the shorter words did not span past the fixation cross, while the longer ones spanned significantly past the fixation cross where their eyes were focused. Therefore, the monolinguals' line of vision cut off the whole word, creating an override effect for the auditory stimulus and allowing a switch of attention to the auditory modality. Monolinguals performed better than bilinguals at this task in both accuracy and reaction times. Their high performance could be a product of the simplicity of the task, as the words shown were very common words where the likely age of acquisition was low. These findings suggest there is no bilingual advantage in this cross-modal setup.

The bilingual group consisted of native speakers and Spanish learners, but first language did not have an influence on their performance outputs. Proficiency level was not a significant factor for performance either. Because of the high frequency of most of the words, novice and proficient bilinguals performed at equal levels of Spanish proficiency. Bilingual subjects performed worse when the word on the screen was different than the word spoken in the headphones. Accuracy was higher when the screen word was the same as the audio word, suggesting that the distractor word had an impact on subject performance. Repetition of the same word causes a faciliatory effect. It is more distracting to have counteracting information spoken while you are trying to read, comprehend, and repeat or translate the target word. When both words are presented simultaneously, a competition of word processing emerges. Participants performed more accurately when the auditory word was presented to both ears rather than the left or right individually. Having both ears stimulated is normal when having a conversation, so when it becomes fully panned left or right, the selective attention switches and the probability for interference increases. The biggest difference between panning conditions was right ear compared to both ears, with more errors in the right; this result goes against the findings in many other studies of a right ear advantage (Desjardins & Fernandez, 2018; Mägiste, 1984; Soveri et al., 2011). Accuracy was lowest when the word on the screen was in Spanish, and reaction times were slower when Spanish was present on the screen. For the heritage speakers, interlingual interference may have caused the decline in performance, while for the Spanish learners, this result is most likely due to the low proficiency in the language. Accuracy was lower and reaction times were slower when the word on screen and in the headphones was in Spanish compared to both words presented in English. Intralingual interference was higher in these two conditions, but Spanish elicited more errors since the task was to translate into English, and the dual English condition was faciliatory. The Spanish on screen and in the headphones allowed more interference to happen within that dictionary, causing competition of word processing. The condition with the highest accuracy was an English screen word with a Spanish audio word, compared to the dual Spanish condition (lowest accuracy). Having the target word in English eliminated the need for a translation, which means the task only required word repetition, like that of the monolingual group. With a simpler task, participants were able to better ignore the distractor stimuli. This condition shows the possibility that a bilingual has the capacity to not activate the dictionary of the opposing language, a feature described by Soveri et al. (2011). Contrary to the monolingual participants, screen word and audio word caused significant effects on subjects' performance. The trials were randomized, forcing participants to switch between their two languages in almost every trial. The switching of languages and activation of dictionaries creates a higher cognitive load and may contribute to bilinguals' lower performance.

CONCLUSION

A frequency effect was observed, where higher frequency words were recognized quickly and more accurately by both monolingual and bilingual groups. Phonetically similar word trials created a significant difference when compared to phonetically similar trials that presented the same word in both modes in Spanish (e.g., "work" on screen, "trabajo" audio). Having English on screen and Spanish in the headphones was faciliatory to performance because it allowed the audio language to not be activated. A bilingual advantage was found, but not to the extent of faster or better performance. The term "bilingual advantage" needs to be clearly defined so that researchers in the field can better compare their conclusions. One would expect similar results in languages that are very similar to each other, like Spanish is to English. Theoretically, the most similar results would be seen between Italian and Spanish. Bilingual discourse would benefit greatly from further research investigating these effects in other language pairs. There is a bias in bilingual research favoring popular languages over smaller, community languages. In order to understand how language affects thought processing, all languages need to be studied. More research needs to be done in order to reach a reliable conclusion on bilingual language effects.

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NOTES

1. "Semantic Power Measured through the Interference of Words with Color-Naming" by George Klein was the oldest I could find, dated 1964.

2. Edith Mägiste in Experiment 1, Color-word task.

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