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CROSS-MODAL DISTRACTION ON SIMULTANEOUS TRANSLATION: LANGUAGE
INTERFERENCE IN SPANISH-ENGLISH BILINGUALS

by

VIOLET ANNE YOUNG

A thesis submitted in partial fulfillment of the requirements
for the Honors in the Major Program in Interdisciplinary Studies
in the College of Undergraduate Studies
and in the Burnett Honors College
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Thesis Chair: Doan Modianos, Ph.D.

ABSTRACT

Bilingualism has been studied extensively in multiple disciplines, yet we are still trying to figure out how exactly bilinguals think. A bilingual advantage has been observed in various experimental studies, but also has not been observed in many other studies. A bilingual advantage 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 examined language interference in Spanish-English bilinguals, using an auditory-visual simultaneous translation experimental setup. 16 college English monolinguals and 17 college Spanish-English bilinguals were tested. The task was to ignore the word in the headphones and to translate/repeat the word on the screen into English. Distractor words went to either the right, left, or both headphone ears. Subjects were given 72 words to translate, words were randomized, and ear of the distractor word was randomized. The monolingual group was not affected by any independent variables tested except screen word length. Bilinguals did worse when the word and audio were in Spanish, and when the word and audio were different words. No ear advantage was observed. Proficiency levels and first language had no effects on bilingual performance. More intralingual interference was observed for bilinguals only, no significant interference occurred for monolinguals. A slight bilingual advantage was found but not fully, because of the high load of the task and introduction of another language. In conclusion, bilinguals did not have a cognitive advantage in this experiment setup.

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Although the Honors in the Major program is geared to make students participant in independent research, the research that has been done has not been independent in the least. This research has been a collaboration between mentors, friends, and family. I thank my thesis chair, Dr. Doan

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Thanks to my friend, Ty Abbott, for helping me map out the auditory conditions, and to my boyfriend, Edrick Rivera, for recording and re-recording all the auditory distractor words. Thank you to my parents for finding and funding the technology used in this experiment, and for providing motivation. Lastly, thank you to the participants for taking the task seriously and trying their best.

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INTRODUCTION

The purpose of this thesis is to evaluate the extent of bilingual's selective attention by a cross-modal simultaneous task. This task will exercise their language and translation abilities. Since this is a new experimental setup, previous experimental setups are discussed and gaps in the research are exhibited in this section.

BACKGROUND

Bilingualism has always been a popular area to study in neuroscience, the results of which are used towards better understanding the psycholinguistics of language. One way to test how bilinguals retrieve and store words in both languages is the Stroop task (1935). In the Stroop task participants are given different colored word names and are asked to respond in what color the word is written in. There are incongruent and congruent colored words; an incongruent colored word would be the word *blue* written in *yellow* ink, in which the correct response would be *yellow*. A congruent word would be written in the same ink as the word says (*red* written in *red* ink). The Stroop task can be modified to test bilinguals. For example, in an English-Spanish bilingual version, in an incongruent condition, the word *green* would be in *red* ink and they would be asked to respond in Spanish (*rojo*). A congruent condition would be the word *blue* written in *black* ink with the response being in English (*black*). 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 has been a good amount of research done on applying the stroop task to bilinguals, the earliest being around the 1960's¹.

The key research done by these experiments is the measuring of differences between interlingual and intralingual interference, by comparing reaction times in the various conditions. The consensus of these results is intralingual interference is higher than interlingual interference (Dyer, 1970; MacLeod, 1991; Preston, 1965). The explanation is described 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).

The interlingual and intralingual interference is also affected by another factor: language proficiency. Mägiste found that the dominant language creates a higher level of intralingual interference than interlingual, but this then switches after 13 years of residence in the second language country² (1984). This implies that your ability to filter out the second language becomes harder as you become more proficient. Both interferences seem to be affected by the similarity of the language (Chen & Ho, 1986). A closer related language like English and Spanish, because they practically share the same alphabet, would have higher interference than Arabic and English, which have very different alphabets.

Another way to see language interference effects in bilinguals is the dichotic listening task. The dichotic listening task measures how auditory language stimuli interferes with verbal, spoken language, usually in the case of simultaneous translation. In the dichotic listening task,

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*.

subjects are given a pair of headphones in which the stimulus is played in one ear, while the other ear either has no noise at all (control) or has distractor words playing. The goal of the participant is to focus only on the ear (indicated by the researcher) that has the words that must be repeated. The task measures selective attention, as you must tune out the distractor words playing in the opposite ear. This task can be modified to test bilinguals by having them simultaneously translate into English or Spanish with either English or Spanish distractor words playing in the other auditory input (or none for control). For example, a participant would be instructed to only translate what they hear in the left ear, as quickly as possible, and to ignore the right ear. An English word would be played in the left ear and would be repeated in English, while another English word is played in the right ear. This would cause intralingual interference because the same language is being played in both ears (congruent condition). Any error in response would be due to the distraction of the English coming from the right ear. Interlingual interference would be present upon introduction of another language in the headphones.

Bilinguals are better at filtering out irrelevant stimuli than monolinguals because they can suppress the language not being used when speaking (Soveri, A., Laine, M., Hämäläinen, H., & Hugdahl, K., 2011). This way they are only channeling one language and can easily ignore the other language that isn't activated. The idea that bilinguals have a higher level of functioning in executive tasks (like the dichotic listening task) and leads to better performance, is called the bilingual advantage. This advantage is explained by Desjardins and Fernandez³ (2017) as “the regular use of two languages requires that bilinguals control their attention and select the target

³ Desjardins and Fernandez's work discusses a lot of research done surrounding the bilingual advantage. I will not go into depth into this research because it is not the primary focus of this experiment.

language, which, in turn, is reflected in greater cognitive control on tasks with distracting information”. It is important to note the term “regular use” in that conclusion, because lays out a limitation on the finding. Bilinguals with less regular use of both languages might not have the same level, if at all, of greater cognitive control.

Few researchers are looking at the bilingual dichotic auditory task in the eyes of inter and intralingual interference like the stroop tasks heavily did. The two papers that analyze the bilingual dichotic listening task in terms of interlingual and intralingual interference is 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. This led to subjects not being affected by the distractor stimuli. Less errors were made when the language of the distractor channel was the same as the translation made. This implies that distractor language does have some effect on accuracy of translations, otherwise it would be a constant level of errors throughout all trials. Lawson suggested this study be reproduced with a bigger set of subjects; her sample size was only 6 educated males. Mägiste performs two experiments: the bilingual Stroop task and a bilingual dichotic listening task, and compares them. 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 conclusion that Soveri produced as well in her dichotic listening task (Mägiste, 1984; Soveri et al., 2011). It is important to include a monolingual group into the setup of the study so that any differences shown in-between groups can either confirm or deny a bilingual advantage. It is important to note that both Lawson and Mägiste did not randomize which ear the participant translates from. They were always either exclusively translating the left ear or right ear, not switching during the experiment. This can easily lead to

better performance due to practice, and right/left ear advantage. Both researchers only measured responses in terms of errors. These might be contributing factors into their conclusions. In my experiment, I will be randomizing the translated ear within subjects, which will include right, left, and both ear stimuli. I will be measuring data based on accuracy (errors) and reaction times in milliseconds, recorded from a serial-response box. Mägiste's procedure used sentences for translation, Lawson used passages from a book for translations, while I will be using a one-word setup so that variables affecting reading comprehension will not be included.

The experimental setup proposed in 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 was chosen based on simplicity and novelty to the research discourse. Having a visual target word on the screen and an auditory distraction word in the headphones was based off existing literature that suggests 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). The speech gains access to the short-term storage of the phonological aspects of the visual information, allowing the distractor speech to cause interference in the cognitive task (Salamé & Baddeley, 1989). Pool et al. (2003) describes this effect due to having limited resources; the dual information might breach the capacity of resources, leading to only one source being processed (limited-capacity theory). This competition of dual modalities (visual and auditory) for resources leads to the decreased output performance in types of working memory cognitive tasks. As the task proposed in this research contains visual verbal information along with distracting auditory information, it is likely that the distractor speech will have a negative effect on subject's performance.

Experimental tasks that include words are highly susceptible to the frequency effect, due to our mental model of word recognition and accession being biased to picking high-frequency words over low (Taft, 1979). The frequency effect is when higher frequency words (more common words) are recognized first or faster than 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, the frequency of that word will increase, 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 later in life (Harley, 2001, p. 158). Basic words are learned first (e.g., hello) and are used more regularly and longer than the specified language gained later in life (e.g., contemporary). As shown in the recent example, more common words are shorter, and take less time saying than longer words (Harley, 2001, p. 160). This means the reaction times could possibly be shorter 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, p.160). Neighbor words are words that are phonetically similar and have one or two letter differences. A trial with the visual and auditory word being neighbors would create the most interference because the word would activate similar dictionaries and compete for processing. Word frequency, length, and phonetics will be evaluated as independent variables in the 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 of this passage 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, and not observed in others, therefore, it is of importance to determine that for this unique experimental setup. The following hypotheses were produced:

Hypothesis 1: Bilinguals will produce less interference than monolinguals.

Hypothesis 2: Less proficient bilinguals will produce more interference than higher proficient bilinguals.

Hypothesis 3: More intralingual interference will be produced across all bilingual subjects.

Hypothesis 4: Phonetically similar words will create more interference in both groups.

Hypothesis 5: Frequency effect will be observed in both groups.

METHOD

PARTICIPANTS

16 normal Spanish-English bilinguals, and 17 normal English monolinguals were studied. All subjects had normal cognitive functioning, no auditory impairments, no visual impairments, and no physical impairments. Two bilingual participants were excluded from the data analysis due to not following the task to its full requirements during the experiment. 3 out of the 33 participants were left handed, and 30 were right handed. All were recruited from the University of Central Florida using their psychology recruitment website SONA⁴. Recruitment occurred during the end of the summer term of 2018 and the beginning of fall term of 2018. All participants received 1 SONA participation credit, which is required and used in participating classes, usually for extra credit in the course. Age for the 33 participants ranged from 18-30 with bilingual average at 20.25 years ($SD = 3.73$), and monolinguals average at 18.64 years ($SD = 1.32$); 51.51% were male. 50% of bilinguals listed Spanish as their first language, 25% said English was, and 25% stated they learned both 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 (Appendix C). Bilinguals were given English and Spanish proficiency tests⁵ (Appendix

⁴ <http://ucf.sona-systems.com/>.

⁵ English questions chosen from “Pre-Intermediate” “Test 1”: #1-10 with #4 name changed from “Hania” to “Emma” for simplicity; from “Intermediate” “Test 6”: #1-10; from “Upper Intermediate” “Test 11”: #1-10. Spanish questions chosen from A1 level: #2-6, #9; from A2 level: #1-3, #7, #9-10; from B1 level: #3-4, #6-9; from B2 level: #2, #4-6, #8-9; from C1 level: #1-6. Each test consisted of 30 questions.

D) as well as self-reported language fluency/acquisition questions (Appendix C). Words from most commonly used Spanish and English compilation websites⁶ were used. Spoken forms of the words were recorded using a computer software system called Audacity, 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). In the match condition, the word on the screen was the same as the word spoken in the headphones. In the mismatch 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. In the bilingual group, 4 conditions existed: 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. Each of these 4 conditions were applied to having either the auditory word stimuli going to the right, left, or both channels of the headphones. An outlined table of these auditory conditions are in Appendix B. Word relationship to audio were matched based on length of the words. These were then imputed into the experiment, built using E-prime v.3.

PROCEDURE

The study was available in person only and took place on the university in the psychology building. Participants were given a general presentation of the experiment and voluntarily decided to sign up for a specific time slot via the SONA website. In the lab they were

⁶ Spanish website citation found under Anderson, C. Used top 200 words only. English website under reference “COCA”, used top 200 words only. NIM used for frequencies in analysis.

given a packet containing the consent form, pre-survey, proficiency tests for English and Spanish (Bilinguals only), and a summary of the experiment. The task was explained in part by the researcher but explained in more detail 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 (pointing to the first button on the serial-response box, labeled ‘1’) to continue onto 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 behind the computer to minimize distractions during the task. Subjects then put on the headphones, read the instructions and began. The task for monolinguals was to repeat the word seen on the screen while ignoring the auditory words spoken in either or both ears. Bilinguals had to translate the word seen on the screen (English or Spanish) into English, while ignoring the spoken words (English or Spanish) in the headphones. The side the audio word is presented switched between left, right and both randomly to account for right ear advantage (REA) or left ear advantage (LEA). The word was presented in the middle of the screen for 1400 ms, followed by a fixation cross in the center. Participants then pressed the first button on the serial-response box to continue onto the next word. Each participant ran through 72 words. Word order was randomized, but the same list of 72 words were given to each group (Bilingual group and Monolingual group). The two groups got different lists because the monolinguals cannot translate Spanish words. The serial-response box recorded reaction times in milliseconds while the computer software recorded their translations/responses. After the task, subjects were given a brief post-task survey asking how the task went, how they felt about it, and any improvements to be made. Then they were issued

their SONA credit for participating. Most participants felt the task was easy (26/33) and they were relaxed.

RESULTS

Three groups of the participants were created: all subjects, monolinguals, and bilinguals; the data 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 making it presented automatically and fast after the instructions screen. Subjects also had a hard time figuring out how to advance to the next word, even though instructions were given verbally and on the instruction screen beforehand. This led to an extremely high reaction time mean. The control (match) condition as used in analysis because both groups were affected differently. An accuracy score = 1 means no errors were made, and a 100% accuracy response occurred. Therefore, means equaling 0.98 have an accuracy of 98%, and a higher accuracy score than 0.87, for example. For interpreting reaction times, the lower the time (in milliseconds) the faster they were. Performance was measured by number of errors (accuracy) and latencies (reaction times). More interference is defined as having slower reaction times and lower accuracies.

ALL SUBJECTS

Caffeine had no influence on reaction time $F(1, 31) = 0.728$, $p = 0.400$, nor accuracy $F(1,31) = 0.622$, $p = 0.436$. There were three left handed subjects (2 bilinguals, 1 monolingual). Handedness had no significant effect on accuracy $F(1, 2341) = 0.095$, $p = 0.757$, nor reaction time $F(1, 2341) = 2.496$, $p = 0.114$. Sex differences were not significant for either reaction time $F(1,2341) = 1.079$, $p = 0.299$, nor accuracy $F(1,2341) = 1.186$, $p = 0.276$. Trial number was significant for performance for both accuracy $F(70, 2272) = 1.505$, $p = 0.005$, and reaction time $F(70, 2272) = 2.393$, $p < 0.0001$. From the music tendency questions in the pre-survey, 4

variables 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. Frequency of music played while studying had no significant effect on reaction time $F(5,27) = 1.079$, $p = 0.394$, nor accuracy $F(5,27) = 0.179$, $p = 0.968$. Music loudness had no significant effect on reaction time $F(8,24) = 1.199$, $p = 0.341$, nor accuracy $F(8,24) = 0.819$, $p = 0.593$. Similarly, music concentration effects had no significant influence on reaction time $F(3,29) = 0.935$, $p = 0.436$, nor accuracy $F(3, 29) = 0.787$, $p = 0.511$. Likewise, helpfulness on performance was not significant for reaction time $F(8, 24) = 1.708$, $p = 0.148$, nor accuracy $F(8, 24) = 0.998$, $p = 0.463$. There were significant difference between the performance of bilinguals and monolinguals; accuracy $F(1, 2341) = 36.550$, $p < 0.0001$, and reaction time $F(1, 2341) = 40.785$, $p < 0.0001$. These are shown in Figures 1 and 2 below.

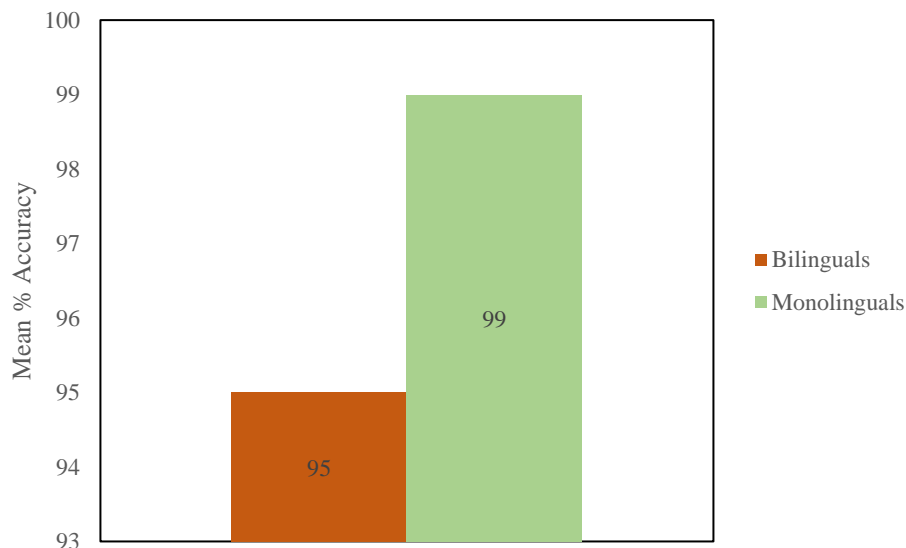


Figure 1: Average % accuracies for both groups, including all conditions.

Note. Monolinguals ($M = 0.99$, $SD = 0.095$); Bilinguals ($M = 0.95$, $SD = 0.220$).

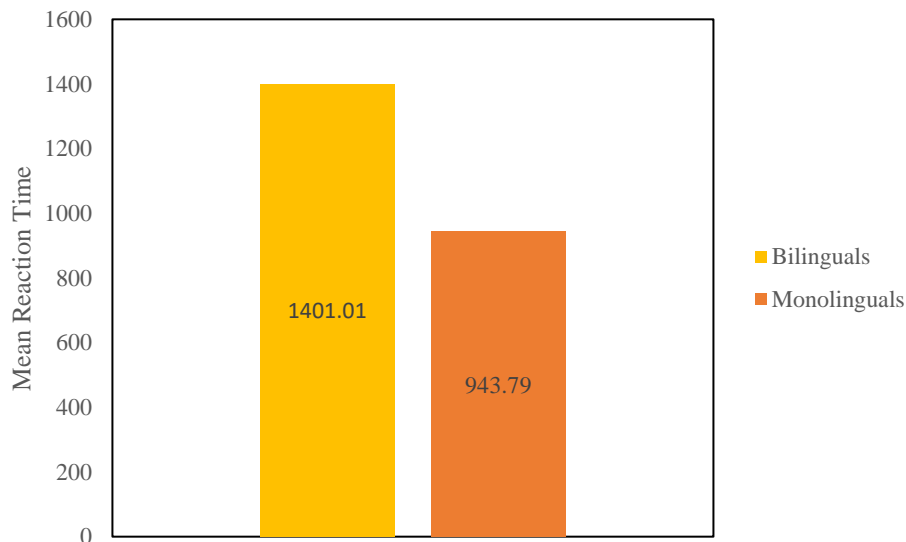


Figure 2: Average reaction times for both groups, including all conditions.

Note. Monolinguals ($M = 943.79$, $SD = 1560.536$); Bilinguals ($M = 1401.01$, $SD = 1897.126$).

MONOLINGUALS

Effects of the two conditions were not significant for accuracy $F(1, 1205) = 0.830$, $p = 0.362$, nor significant for reaction time $F(1, 1205) = 0.390$, $p = 0.533$. Ear in which the distractor stimuli reached was not significant for accuracy $F(2, 1204) = 0.027$, $p = 0.973$, nor reaction time $F(2, 1204) = 0.479$, $p = 0.619$. Whether the auditory distractor word went to both ears vs an individual ear had no significant difference on accuracy $F(1, 1205) = 0.055$, $p = 0.815$, nor reaction time $F(1, 1205) = 0.200$, $p = 0.655$. Regarding the linguistic side of the experimental setup, 4 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 word had no significant results for accuracy $F(35, 1171) = 0.915$, $p = 0.612$, nor reaction time $F(35, 1171) = 1.054$, $p = 0.384$. Frequency of the audio word was equally as not significant for accuracy $F(71, 1135) = 0.869$, $p = 0.771$, nor reaction time $F(71, 1135) = 0.816$, p

= 0.862. However, length of screen word had a significant effect on accuracy $F(5, 1201) = 2.607$, $p = 0.024$, but not on reaction time $F(5, 1201) = 0.293$, $p = 0.917$. A negative correlation was found between accuracy and length of screen word, the higher the length of the word, the lower the accuracy became. Minimum word length was 2 letters ($M = 1.00$, $SD = 0.000$), and maximum word length was 7 letters ($M = 0.96$, $SD = 0.196$). Length of audio word had no significant effects on participant's accuracy $F(6, 1200) = 1.437$, $p = 0.197$, nor reaction time $F(6, 1200) = 0.610$, $p = 0.722$. Phonetically similar words had no influence on performance of subjects for either accuracy $F(1, 1205) = 1.394$, $p = 0.238$, or reaction time $F(1, 1205) = 0.026$, $p = 0.872$.

BILINGUALS

From the background section of the surveys, two variables were tested using an ANOVA test: proficiency level and first language. Self-proficiency level questions were asked, and the results of the proficiency tests were graded. If a subject missed 3 or more in any section (3/6 = 50% fail) then they were said to be proficient in the previous section that they received a passing score on. For example, if a subject got 4/6 questions wrong in the B2 level, and only 2/6 questions wrong in the B1 level, they were marked as being proficient in Spanish at the B1 level. There were 5 levels of scoring for Spanish, and 3 levels of proficiency for English. All subjects scored as highly proficient in the English section. Only 5 out of the 16 bilinguals scored highly proficient in Spanish, while 11/16 self-reported they were highly proficient in Spanish. The questions were based on grammar, and the most appropriate and grammatically correct was said to be correct. Proficiency level had no significant influence on accuracy $F(3, 12) = 1.281$, $p = 0.325$, nor reaction time $F(3, 12) = 1.161$, $p = 0.365$. Half of subjects listed Spanish as their first language, 4/16 listed English, and 4/16 listed both. First language had no significant effects on

accuracy $F(2, 13) = 0.582, p = 0.573$, nor on reaction time $F(2, 13) = 0.562, p = 0.583$. Whether the auditory distractor word went to both ears vs an individual ear had significant difference for accuracy only $F(1, 1134) = 10.955, p = 0.001$, with accuracy rates higher for both ear stimuli ($M = 0.96, SD = 0.186$) than an individual ear ($M = 0.92, SD = 0.274$). Individual vs both ear presentation almost had a significant effect on RT $F(1, 1134) = 3.379, p = 0.066$. Effects of the language of the word on the screen is significant for accuracy $F(1, 1134) = 26.662, p < 0.0001$, and reaction time $F(1, 1134) = 4.724, p = 0.030$. Accuracy is higher when the word on screen is in English ($M = 0.98, SD = 0.132$) than Spanish ($M = 0.92, SD = 0.278$), and reaction time is lower for when in English ($M = 1278.65, SD = 1914.046$) vs Spanish ($M = 1522.93, SD = 1873.853$). Language the auditory distractor word was in had a significant influence on accuracy only $F(1, 1134) = 10.454, p = 0.001$. There were more errors when the language was Spanish ($M = 0.93, SD = 0.259$) than English ($M = 0.97, SD = 0.171$). The relationship between the word on screen and the audio word created a significant effect on accuracy only $F(1, 1134) = 7.227, p = 0.007$, with more errors in the experimental condition ($M = 0.93, SD = 0.253$) than the control condition ($M = 0.97, SD = 0.180$). Ear to which the distractor word arrived to had a significant effect on accuracy $F(2, 1133) = 6.279, p = 0.002$, both ears having the highest accuracy ($M = 0.96, SD = 0.186$) and the left ear having a higher accuracy ($M = 0.93, SD = 0.251$) than the right ($M = 0.90, SD = 0.295$). 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	0.028	0.022	0.207
		3	-0.032	0.018	0.074
	2	1	-0.028	0.022	0.207
		3	-0.060*	0.018	0.001
	3	1	0.032	0.018	0.074
		2	0.060*	0.018	0.001

* $p < 0.05$

Note. The only significant comparison is 2 vs 3 (right ear vs both). 1 vs 3 almost significant.

The condition of the word and distractor stimuli had significant effects on the accuracy $F(3, 1132) = 10.095, p < 0.0001$, of the participants. Conditions will be listed in the format (screen word language, auditory word language). The highest accuracy was in the second condition (E, S) with ($M = 0.99, SD = 0.084$); the condition that produced the most errors was condition 4 (S, S) with ($M = 0.91, SD = 0.292$). The first condition (E, E) had ($M = 0.98, SD = 0.144$), and the third condition (S, E) had ($M = 0.94, SD = 0.231$). It was also significant on RT in the LSD post test for condition 1 (E, E) vs 4 (S, S) only ($MD = -261.626, SE = 129.862, p = 0.044$), even though ANOVA RT was not significant $F(3, 1132) = 1.741, p = 0.157$.

Table 2

LSD test for Condition x Accuracy One-Way ANOVA test.

D.V.	I	J	MD	SE	P
Accuracy	1	2	-0.014	0.021	0.503
		3	0.035	0.021	0.096
		4	0.073*	0.015	0.000**
	2	1	0.014	0.021	0.503
		3	0.049	0.026	0.057
		4	0.087*	0.021	0.000**
	3	1	-0.035	0.021	0.096
		2	-0.049	0.026	0.057
		4	0.037	0.021	0.077
	4	1	-0.073*	0.015	0.000**
		2	-0.087*	0.021	0.000**
		3	-0.037	0.021	0.077

* $p < 0.05$ ** $p < 0.01$

Note. Only significant differences are 4 vs 1, and 4 vs 2; 3 vs 2 and 3 vs 4 almost significant.

Linguistically, the same 4 variables tested for monolinguals were tested for effects on performance in bilinguals. Unlike the monolingual participants, screen word frequency created significant effects on accuracy $F(35, 1100) = 2.376, p < 0.0001$, and audio word frequency on accuracy $F(68, 1067) = 1.639, p = 0.001$. The screen words “pasa” ($M = 0.75, SD = 0.440$), “tiene” ($M = 0.83, SD = 0.385$), and “eres” ($M = 0.86, SD = 0.351$) had the lowest accuracy

scores. A positive correlation was observed, with higher frequency words having a higher accuracy score. The audio words “quiero” ($M = 0.75$, $SD = 0.447$), “pasa” ($M = 0.75$, $SD = 0.447$), “casa” ($M = 0.75$, $SD = 0.447$) had the lowest accuracy scores. Reaction times for both frequency of screen word $F(35, 1100) = 1.254$, $p = 0.149$, and frequency of audio word $F(68, 1067) = 0.903$, $p = 0.696$, were not significant. Length of screen word on reaction time was not significant $F(4, 1131) = 1.468$, $p = 0.210$, and not significant for accuracy $F(4, 1131) = 1.641$, $p = 0.162$. Length of audio word was also not found to be significant for accuracy $F(4, 1131) = 0.372$, $p = 0.829$, nor reaction time $F(4, 1131) = 0.861$, $p = 0.487$. 4 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 for subjects’ accuracy scores $F(3, 1132) = 1.665$, $p = 0.173$, or reaction times $F(3, 1132) = 0.418$, $p = 0.740$. Yet, an LSD test for Phonetic type x Accuracy gave significance for the difference between phonetically similar ($M = 0.91$, $SD = 0.220$) and phonetically similar with same word but audio word in Spanish ($M = 1.00$, $SD = 0.000$), ($MD = -0.090$, $SE = 0.046$, $p = 0.052$).

DISCUSSION

As the trials went on, all participants had higher accuracies and faster reaction times, given that they had more practice and gained knowledge of how the task worked. There were no significant differences in performance between male and female participants, suggesting that one sex is not any better at the task than the other. The task was not susceptible to caffeine intake. Having 3 left handed participants did not impact the data. None of the music tendency variables created significant results. Whether the participants always listened to music during studying or they rarely did, made no difference in their performance at this task. This suggests there is no advantage to students who do listen to music while studying, even when at a high-volume level.

The purpose of the monolingual group was to act as a control group (one language) to see the full effects of adding another language to this task. It was also to investigate if a bilingual advantage existed or not. 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 their output performance. However, the length of the word on the screen had influence on their accuracy scores. The longer the word, the more errors they made. A hypothesis for this effect is that the shorter words did not span past the fixation cross, while the longer ones (e.g., program) spanned significantly past the fixation cross where their eyes were focused on. Therefore, their line of vision cut off the whole word, creating an override effect for the auditory stimulus, allowing a switch of attention to move to the auditory modality. Comparing monolinguals to bilinguals, monolinguals performed better at the task in both accuracy level and faster 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 not a 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 and commonality of most of the words, novice and proficient bilinguals were put on an equal level of Spanish proficiency. More in depth, 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. This suggests that the distractor word had some impact on subject performance. Having the same word repeated causes a facilitatory effect. It is more distracting to have counteracting information (a different word) spoken while you are trying to read, comprehend, and repeat or translate the target word. When both are presented simultaneously, there becomes a competition of word processing. Participants had higher accuracy when the auditory word was presented to both ears rather than individually left or right. 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 gap was right ear compared to both ears, with more errors in the right, going 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 higher when Spanish was present on the screen. For the heritage speakers, interlingual interference may be causing the decline in performance, while for the Spanish learners, it is most likely due to the low proficiency in the language. Accuracy was lower and reaction times slower when the word on screen was in Spanish and the word in the headphones was in Spanish when

compared to both 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 facilitatory. The Spanish on screen and in the headphones allowed more interference to happen within that one 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, akin to the monolingual group. With the task being simpler, 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) in the background section. A bilingual advantage was defined to be supported by evidence in resulted performance, but this feature might be up for contention even in areas where the results do not favor bilinguals. Contrary to the monolingual participants, screen word and audio word caused significant effects on subjects' performance. The trials were randomized which means they were switching between their two languages theoretically on every trial. Switching of languages and activation of dictionaries is a higher cognitive load and may be cause into bilinguals' lower performance.

A frequency effect was observed, where higher frequency words were recognized first and had higher accuracies. Phonetically similar word trials created a significant difference when compared to phonetically similar trials that had the same word but audio word in Spanish (e.g., “work” on screen, “trabajo” audio). Parallel to the language conditions results, having English on screen and Spanish in the headphones is facilitatory because it allows the audio language to not

be activated. A bilingual advantage was found, but not to the extent of faster or better performance.

IMPLICATIONS

Hypothesis 1: Bilinguals will produce less interference than monolinguals. Hypothesis is not supported by the data due to the results of bilinguals having lower accuracy scores and slower reaction times.

Hypothesis 2: Less proficient bilinguals will produce more interference than higher proficient bilinguals. Proficiency levels had no significant effects on performance. Hypothesis is not supported by the data.

Hypothesis 3: More intralingual interference will be produced across all bilingual subjects. More intralingual interference was observed since the condition with the highest amount of errors was the Spanish, Spanish condition. Hypothesis is supported by the data.

Hypothesis 4: Phonetically similar words will create more interference in both groups. Phonetics caused interference in the bilingual group only, and only when compared to same word with Spanish in headphones condition. Hypothesis is slightly supported by data.

Hypothesis 5: Frequency effect will be observed in both groups. Frequency effect was observed only in the bilingual group; hypothesis is slightly supported by the data.

EXPERIMENT BOUNDARIES

Participant's hearing levels were not tested prior to the experiment. Testing their hearing would have ensured that the auditory words affected every participant equally the same and to the full extent. Multiple participants double or even triple clicked the button between trials,

which may or may not have affected the data. As stated previously, the bilingual group featured a mixture of native or heritage speakers and Spanish learners. Age of acquisition of each word can vary significantly between subjects, affecting their performance scores. This is a confounding variable in all bilingual experiments since no two bilinguals will ever have the same exact age of acquisition for each word. Translation experience and vocabulary size can affect performance as well. If a subject learned certain words in Spanish only and others in English, it is likely that they practice code switching, and communicate with Spanglish. Their translation skills of the word learned in Spanish to English would be difficult if not impossible based on the absence of the word in the opposite dictionary.

FUTURE WORK

It is recommended that this study be improved to minimize confounding variables and replicated in order to solidify the findings. It should be replicated with more participants and include all the resolutions to the errors listed above. Having more participants would increase the power of the tests and may alter some results that had close to significant p values. A third condition should be added: a condition with no auditory distractor words. This would serve as a reading baseline and show the full effects of having auditory distraction on the task and would contribute to the previous literature investigating the role of background speech on cognitive tasks. A more reliable Spanish proficiency test should be used and have the same number of levels as the English proficiency tests as to yield equal and more reliable results. Two separate bilingual groups should be created, one with heritage speakers and one with Spanish learners, in order to see how increasing mastery of the language plays effect into language interference. Word length and frequency should be matched in order to see the full effects of the auditory distraction on translation, since these could be confounding variables. Auditory words should be

matched on decibels in order to not cause a loudness effect. If phonetic effects are the goal, there should be more trials exhibiting the different conditions.

APPENDIX A: IRB APPROVAL LETTER



University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1
FWA00000351, IRB00001138**

To: **Doan T. Modianos and Co-PI: Violet Young**

Date: **June 14, 2018**

Dear Researcher:

On 06/14/2018 the IRB approved the following human participant research until 06/13/2019 inclusive:

Type of Review: UCF Initial Review Submission Form
Expedited Review

Project Title: Dichotic Distraction on Visual Translation: Inter and Intralingual Interference in Spanish-English Bilinguals.

Investigator: Doan T. Modianos

IRB Number: SBE-18-13930

Funding Agency:

Grant Title:

Research ID: n/a

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30 days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at <https://iris.research.ucf.edu>.

If continuing review approval is not granted before the expiration date of 06/13/2019, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the [Investigator Manual](#).

This letter is signed by:

A handwritten signature in black ink, appearing to read "Gillian Morien". The signature is fluid and cursive, with a prominent initial "G" and a long, sweeping tail.

Signature applied by Gillian Morien on 06/14/2018 04:21:58 PM EDT

Designated Reviewer

APPENDIX B: AUDITORY CONDITIONS

Table 3

Auditory Conditions for Bilinguals

Left Ear	Right Ear	Word on Screen	Translate into
-	English	English	English
Both English	Both English	English	English
English	-	English	English
-	English	Spanish	English
Both English	Both English	Spanish	English
English	-	Spanish	English
-	Spanish	English	English
Both Spanish	Both Spanish	English	English
Spanish	-	English	English
-	Spanish	Spanish	English
Both Spanish	Both Spanish	Spanish	English
Spanish	-	Spanish	English

Note. Both English means word went to both ears and was in English.

APPENDIX C: PRE-SURVEY QUESTIONS

PRE-SURVEY QUESTIONS BILINGUALS

1. Are you 18 years or older?

-Yes

-No

2. Are you a UCF student?

-Yes

-No

3. What year are you?

-Freshman

-Sophomore

-Junior

-Senior

-Graduate student

4. What gender do you identify as?

-Female

-Male

-Other _____

5. What biological sex were you born as?

-Female

-Male

6. Are you right handed or left handed?

-Right

-Left

-Ambidextrous (both)

7. Have you ingested anything with caffeine in it in the past 6 hours before this?

8. Do you consider yourself Hispanic/Latino/a

-Yes

-No

-Other _____

9. Do you consider yourself fluent in English?

-Yes

-No

10. Do you consider yourself fluent in Spanish?

-Yes

-No

11. Which was your first language?

-Spanish

-English

-Both at the same time

12. When did you first learn English?

13. When did you first learn Spanish?

14. Select which ones you can do:

	Can't	Somewhat Well	Well	Moderately Well	Very Well	Fluent
Understand English	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Read English	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Speak English	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Write in English	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understand Spanish	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Read Spanish	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Speak Spanish	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Write in Spanish	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other

15. What is your proficiency in English?

-Fluent

-High

-Medium

-Low

-Other _____

16. What is your proficiency in Spanish?

-Fluent

-High

-Medium

-Low

-Other _____

17. Do you listen to music when you study?

-Always

-Most of the time

-About half of the time

-Sometimes

-Rarely

-Never

-Other _____

18. How loud is the music when you study? Answer 0 if you don't listen to music when studying.

Barely noticeable (1)

Can hear it through the walls (10)

0 1 2 3 4 5 6 7 8 9 10

19. Do you find it hard to concentrate on your task if the music is loud?

-Yes a lot

-Moderately

-Not that much

-No

-Other _____

20. How does music affect your studying? Answer 0 if you don't listen to music when studying.

Hurts a lot (1)

Neither hurts nor helps (5)

Helps a lot (10)

0 1 2 3 4 5 6 7 8 9 10

You will now be given a short English and Spanish proficiency test. It consists of 60 fill in the blank questions. The score does not matter, it is just used for data purposes. Please do your best.

Note. The monolingual survey is the exact same, without the questions asking about fluency (questions 8-16).

APPENDIX D: FLUENCY TESTS

1. I would like to go ____ for my holiday next year.

- a.) abroad
- b.) outside
- c.) foreign

2. When I told him about it, he ____.

- a.) just laughed
- b.) has just laughed
- c.) was just laughing

3. Please ask ____ come in.

- a.) him
- b.) him to
- c.) to him to

4. Is ____ than her boyfriend?

- a.) taller Emma
- b.) Emma taller
- c.) Emma more tall

5. Is the boss still in his office? I don't think ____.

- a.) it
- b.) that
- c.) so

6. He wanted to ____ some money from me.

- a.) lend
- b.) lent
- c.) borrow

7. I don't like pasta, and my wife doesn't ____.

- a.) either
- b.) too
- c.) neither

8. You ____ drive slowly through the village.

- a.) must
- b.) need
- c.) want

9. She was 30 on her birthday, ____ she?

- a.) didn't
- b.) wasn't
- c.) hadn't

10. Is he a relative of ____?

- a.) your
- b.) yours
- c.) your's

11. Can you lend me ____ scissors?

- a.) a
- b.) two
- c.) a pair of

12. I ____ have tea than coffee.

- a.) would rather
- b.) prefer
- c.) would like

13. It will cost a lot of money to have ____.

- a.) that work done
- b.) that work made
- c.) made that work

14. Good ____! I hope you win.

- a.) chance
- b.) wish
- c.) luck

15. Take an umbrella ____ it rains while you are out.

- a.) if
- b.) in case
- c.) because

Please select "pants" for this question.

- a.) socks
- b.) hat
- c.) pants

16. If you ____ soon, we'll miss the start of the film.

- a.) aren't coming
- b.) won't come
- c.) don't come

17. I ____ my English lessons because they're very interesting.

- a.) please
- b.) enjoy
- c.) amuse

18. ____ that you would be at the meeting.
a.) It was told me
b.) It was said
c.) I was told
19. I'll ring you when I ____ the guest house.
a.) arrive at
b.) arrive to
c.) will arrive to
20. Kate's got a much more interesting ____ in the company now.
a.) work
b.) job
c.) employ
21. John's shirt is ____ yours.
a.) the same than
b.) similar than
c.) similar to
22. We've proved that he was guilty but he ____ doesn't admit it.
a.) yet
b.) already
c.) still
23. If I ____ the mistake, I would have corrected it.
a.) would have noticed
b.) had noticed
c.) noticed
24. Every old house like this has ____ strange stories.
a.) its
b.) their
c.) the
25. That's my name on the document but it isn't my ____.
a.) mark
b.) signature
c.) sign

26. "I'm going to the cinema tomorrow." 'So ____.

- a.) do I
- b.) am I
- c.) I am

27. He came to the party ____ he hadn't been invited.

- a.) in case
- b.) even
- c.) although

28. I wanted to write to him but he ____ give me his address.

- a.) hadn't
- b.) hasn't
- c.) wouldn't

29. Paul fell down and broke his wrist ____ was a pity.

- a.) which
- b.) what
- c.) that

30. They were all on the platform, waiting ____ arrive.

- a.) for the train
- b.) the train to
- c.) for the train to

----- Spanish -----

1. ¿Qué hora es?

- a.) Son la una y media
- b.) Es una media
- c.) Es la una y media

2. ¿Qué van a tomar? _____ gazpacho.

- a.) para primero
- b.) por primero
- c.) de primero

3. A mis amigas ____ las compras.

- a.) les gusta
- b.) les gustan
- c.) gusta
- d.) gustan

4. No me gusta nada la ópera.

- a.) A mí tampoco
- b.) A mí también
- c.) Yo tampoco
- d.) Yo también

5. Los hijos de me tío son mis _____.

- a.) primos
- b.) nietos
- c.) hermanos

6. Voy a cerrar la Ventana porque tengo _____.

- a.) frío
- b.) calor
- c.) sed

7. ¿Ha venido _____ estudiante?

- a.) alguien
- b.) algún

8. ¿Dígame? Hola, _____ Juan.

- a.) soy
- b.) es

9. Ayer Andrés no _____ sus libros.

- a.) trayo
- b.) traje
- c.) traje

10. No _____ aquí. Está prohibido.

- a.) fumes
- b.) fumas

11. Y tú, ¿Cuándo volviste a Colombia?

- a.) Tres años pasados
- b.) Hace tres años
- c.) Tres años

12. El otro día se me rompió el coche y tuve que Volver a casa _____ pie.

- a.) a
- b.) de
- c.) por

13. Este ejercicio ___ mal.

- a.) es
- b.) está

14. La farmacia está cerrada ___ vacaciones.

- a.) por
- b.) para

15. Si ___ 10 años menos, daría la Vuelta al mundo.

- a.) tendría
- b.) tuviera

Elige “azul” por favor.

- a.) Amarillo
- b.) Azul
- c.) Verde

16. Me molesta que la gente ___ en el restaurante.

- a.) grite
- b.) grita

17. Cuando ___ mayor, viajaré por todo el mundo.

- a.) sea
- b.) soy
- c.) seré

18. ¿Qué hora es? Pues no sé, ___ las diez.

- a.) serán
- b.) son

19. Ana y José, ___ ya que es tarde.

- a.) levantados
- b.) levantaos

20. La mayoría de los estudiantes ___ el examen.

- a.) aprobaron
- b.) aprobó

21. Lo tendré terminado ___ el viernes.

- a.) por
- b.) para

22. El concierto ___ en el auditorio nacional.

- a.) estará
- b.) será

23. Si ____ venido a la fiesta, hubieras conocido a mi hermano.

a.) hubieras

b.) habrías

24. Por muy lejos que ____, siempre llega a tiempo.

a.) vive

b.) viva

c.) vivía

25. ____ un chico muy abierto. Le encanta hablar con todo el mundo.

a.) es

b.) está

26. Se me ____ las llaves.

a.) he perdido

b.) han perdido

c.) ha perdido

27. No creo que lo _____.

a.) había hecho

b.) hubiera hecho

c.) hizo

28. La mujer ____ vimos ayer, es la mujer de Juan.

a.) quien

b.) que

29. Sentí que alguien ____ a la Puerta.

a.) llamara

b.) llamaba

30. Viene porque le obligan y no porque ____.

a.) quiere

b.) quiera

Note. Correct answers are highlighted in grey. The questions about pants and azul were included to make sure the subjects were not just circling random answers. If either of those questions were missed, it would be clear that they did not try their best or pay attention to the questions. All participants answered both questions correctly.

APPENDIX E: CORRECT TRANSLATIONS

Table 4

Acceptable translations for all words used.

Word on screen	Translations	Audio	Translations
ahora	now	quiero	I want
tiene	he/she has	gracias	thank you, thanks
sólo	by yourself, only	cómo	what
bueno	good	puedo	I can
ver	to see, look	cuando	when, as
fue	he/she went, was, go	ser	to be
eres	you are	vez	time
ella	she	todo	everything
nada	nothing	hacer	to do
puede	he/she can, able	ella	she, her, woman
pasa	what's up, skip, past, pass, happens	señor	him, man, Mr.
hola	hello, hi	ese	that
nunca	never	casa	house
verdad	right, correct, truth, true	sus	theirs
dos	two	quieres	you want
decir	to say, to tell, speak	trabajo	work
tiempo	time	dios	god
tan	tan, as, very	mucho	a lot

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