Is There a Cognitive Advantage for Spanish Heritage Bilinguals? A First Look

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ABSTRACT
We report the findings from an ongoing study on the relationship between bilinguals' language experience and cognitive control. Previous research suggests that early bilingualism exerts an advantage on executive control, possibly due to the cognitive requirements involved in the daily juggling of two languages (Adesope, Lavin, Thompson, & Ungerleider, 2010). However, other researchers also have argued against a cognitive control advantage in bilinguals (Hilchey & Klein, 2011). It remains unclear whether cognitive benefits hold true for bilinguals across different contexts, given differences in sociolinguistic and socioeducational settings that shape individual bilingualism. In the current study, following Costa, Hernández and Sebastián-Gallés (2008) who tested Catalan-Spanish bilinguals, young adult simultaneous heritage bilinguals and late classroom emerging bilinguals of Spanish in the U.S. completed three blocks of the Attentional Network Task (ANT) (Fan, McCandliss, Sommer, Raz, & Posner, 2002) to gauge executive control abilities. Results for the executive network component of the ANT reveal no significant differences between the two bilingual groups, although the descriptive data trend suggests that HL bilinguals experienced less difficulty in solving conflicting information and demonstrated fewer switching costs between trials. These first findings imply that the bilingual advantage is not replicated across contexts, and that socioeducational practices determine individual patterns of language use, which in turn leads to variation in cognitive outcomes.

KEYWORDS: *Spanish heritage bilinguals, bilingual advantage, cognition, executive control, Attentional Network Task*

INTRODUCTION

A major task that bilinguals face in daily communication is to suppress one of their languages when the context requires it, often because their interlocutor does not share one of their languages. Bilinguals need to employ cognitive mechanisms to solve this dilemma as evidence suggests languages are simultaneously active while stored in a single bilingual mental lexicon (Kroll & Bialystok, 2013; Kroll & Sunderman, 2003). Green's (1998) Inhibitory Control Model posits that bilinguals rely on executive control processes to inhibit the language that they do not wish to use. Inhibition requires attention to a target stimulus while simultaneously ignoring salient stimuli that compete for attentional resources. More recently, though, research on bilingual cognition has expanded and questioned this notion of inhibitory control, and propose that other executive functioning processes may be involved in the management of two languages, including goal maintenance and monitoring/shifting (Green & Abutalebi, 2013; Bialystok, 2015). Given that early bilinguals have a lifetime of experience exercising the suppression of the

irrelevant language in favor of the one being used, as well as that this practice is related to executive control abilities, early research sought to investigate whether this constant exercise grants early bilinguals superior executive control performance in nonlinguistic cognitive tasks (e.g., Bialystok, Craik, Klein & Viswanathan, 2004).

Bialystok (2007, 2009) and Bialystok, Craik and Luk (2012) offer an overview of studies that support the notion that growing up with two languages gives bilingual individuals an edge in nonlinguistic cognitive tasks in which participants solve conflicting information that competes for attention. This edge has been popularly referred to as the *bilingual advantage.* A meta-analysis by Adesope, Lavin, Thompson, and Ungerledier (2010) found a large effect size for a number of studies that compared attentional control in both monolingual and bilingual populations, suggesting a bilingual advantage in executive control abilities. Additionally, a recent brain study, by Olulade, Jamal, Koo, Perfetti, LaSasso and Eden (2015), provided neuroanatomical evidence for a bilingual advantage, as bilinguals in their study demonstrated larger gray matter volume in brain areas that serve executive functioning.

But some researchers have questioned whether a bilingual advantage indeed exists (e.g., Hilchey & Klein, 2011), with a handful of empirical studies suggesting that the bilingual advantage may not be equally pronounced for different types of bilinguals or may not exist at all (e.g., Colzato, Bajo, Wildenberg, Paolieri, Nieuwenhuis, La Heij, & Hommel, 2008; Paap & Greenberg, 2013). This is an important issue to investigate, as different sociolinguistic situations lead to various linguistic outcomes (Sanz, 2000), and consequently, to differences in cognitive advantages, as these can be present or absent, or even be present in various degrees (as suggested in Kroll and Bialystok, 2013).

Research on heritage language (HL) bilinguals has been on the rise, and the field has primarily focused on describing and explaining the properties of their grammars in the HL (e.g., Benmamoun, Montrul, & Polinsky, 2013), capturing links between identity and the HL (e.g., Hornberger & Wang, 2008) as well as how they respond to pedagogical interventions in the HL as adults (Bowles, in press). Yet, little attention has been devoted to how HL bilinguals' linguistic experience with a minority and family language in a U.S. context may influence cognitive outcomes associated with the bilingual experience. While many of the bilingual participants tested in studies on cognitive control presumably fit the profile of HL speakers, none of them specifically screened their participants for this subgroup of bilinguals.

The goal of this research project is to extend this inquiry to early, simultaneous Spanish/English heritage language (HL) bilinguals in comparison to late classroom emerging bilinguals of Spanish whose language use is mostly restricted to a classroom environment. We adopt a *narrow* definition of heritage bilingual, as defined by Polinsky and Kagan (2007); that is, speakers who have some degree of proficiency in the HL from an early age, but whose dominant language shifted to English during school-age years. The inclusion of U.S. late classroom emerging bilinguals is to serve as a comparison group, as positive effects for superior cognitive control performance are expected for the HL bilinguals due to their lifelong experience managing two languages. Results of the current study are further compared to those of Costa, Hernández, &

Sebastián-Galles (2008) who investigated bilingualism and cognition among Catalan/Spanish bilinguals. Their study, like ours, tested young college-educated participants using the Attentional Network Task in their design as a measure of cognitive control (Fan, McCandliss, Sommer, Raz, & Posner, 2002). Importantly, the two studies have key differences related to societal and individual bilingualism: In Costa et al., participants were highly proficient Catalan/Spanish biliterate bilinguals living in a socioeducational context that promotes additive bilingualism, including universal access to bilingual education. In contrast, our participants are English/Spanish heritage bilinguals with lower proficiency in Spanish, their heritage language and educated in mainstream monolingual English programs.

THEORETICAL BACKGROUND

The Bilingual Advantage in Young Adults

The most substantial work to date on the bilingual advantage in executive control has been carried out by Bialystok and colleagues, using a variety of cognitive tasks and a range of bilingual participants across age groups. Given the population of the current study, the following section summarizes specifically the research with young bilingual adults and cognitive control (Bialystok, Craik, Klein, & Viswanathan, 2004; Bialystok, Martin, & Viswanathan, 2005; Bialystok, Craik, & Luk, 2008; Costa et al., 2008; Hernández, Costa, Fuentes, Vivas, & Sebastián-Gallés, 2010; Luk, De Sa & Bialystok, 2011).

Bialystok, Craik, Klein and Viswanathan (2004) administered a Simon Task to a population of young (ages 30 to 54) and older (ages 60 to 88) monolinguals and bilinguals to investigate whether the bilingual advantage was present in adults. In the Simon Task, participants see either a blue or red square on a computer screen, and have to press a corresponding computer key that matches the color square. In congruent trials, the color square appeared on the same side of the screen of the corresponding computer key; however, the opposite occurred for the incongruent trials. The Simon effect refers to the participants' slower response time on the incongruent trials, which is seen as a reflection of the higher cognitive effort it takes to inhibit the opposite location of the color square. The researchers found that the mean reaction time on the incongruent trials was significantly smaller for the bilingual participants regardless of age. In another study, Bialystok, Martin, and Viswanathan (2005) reported results from a Simon Task for children, young and older adults, and while overall the bilinguals outperformed the monolinguals, they did find no difference between the young college-aged monolingual and bilingual students. According to the authors, this is due to the fact that young college-aged students are at the peak of their cognitive development.

Bialystok, Craik, and Luk (2008) tested younger and older mono- and bilingual participants, relying on multiple techniques that tested for executive control (the Simons Arrows Task, the Stroop-color naming task and Sustained Attention to Response Task, or SART). In this Simon Arrows Task, participants saw a number of arrows on the screen, and were instructed to focus on the center arrow pointing either right or left and to press a corresponding key as accurately and quickly as possible that reflected the direction of the arrow. The conflict condition consisted in the arrows on the side going on the opposite side of the center arrow. The Stroop-color naming task consisted of color names (red, green, blue) that appeared in the center of the screen. The

color condition presented a series of Xs in one of the target colors; the word condition presented the matching color word and color font; and the Stroop consisted of the mismatch between the color name and color font, but instead of pressing a key, participants named the color of the font into a voice response key. The SART was used to measure the participants' sustained attention. Participants saw a number from *1-9* presented in the center of the screen and had to press a response key except when they saw the number *3*. If participants saw the number *3*, they were instructed not to press the response key and to wait for the following number.

Results showed both younger and older bilinguals outperforming their monolingual counterparts in both the Simon and Stroop tasks, as they were significantly faster in conflicting conditions. However, no differences were found for the SART. The researchers concluded that the bilingual experience shapes certain, but not all, aspects of inhibitory control. That is, for the Simon and Stroop tasks, bilinguals had to solve two conflicting dimensions of the task, especially when two features of the task do not correspond, like the color and the position of the stimulus on the computer screen in the Simon task. Similarly, bilinguals needed to solve the conflict resulting in the activation of two languages competing to communicate an idea or thought.

Hernández, Costa, Fuentes, Vivas, and Sebastián-Gallés (2010) tested young Catalan-Spanish bilinguals and Spanish monolinguals with a numerical Stroop task in which participants had to press as quickly and accurately as possible a key (1, 2 or 3) that corresponded to the number of items on the screen. The incongruent trials had a mismatch between the items that appeared on the screen and the digits displayed (e.g., 3, 11, 222). Their results showed that bilingual participants were faster across all conditions, and that a bilingual advantage emerged in solving conflicting information in the incongruent trials.

Luk, De Sa, and Bialystok (2011) examined whether the bilingual advantage extended to young late bilinguals with an average age of onset of active bilingualism at 15,9 years old. Early, late bilingual, and monolingual participants completed a flanker task that required participants to indicate the direction of a red chevron on the screen by pressing a left or right computer key. The incongruent trials consisted of distractor black chevrons that pointed to the opposite direction of the red chevron. The findings revealed that only early bilinguals were significantly better at inhibiting interference during the flanker task, thus implying that a substantial longer period of manipulating two languages is what confers advantages in a non-linguistic cognitive task.

Lack of Evidence for the Bilingual Advantage in Young Adults

Despite the evidence above, the idea of a bilingual advantage has been challenged. Some studies have failed to replicate the executive control advantage, or have questioned whether this advantage can be attributed to superior inhibitory control abilities. In their extensive review, Hilchey and Klein (2011) challenged the theoretical notion that the superior performance of bilinguals on these nonlinguistic cognitive tasks (e.g., Simon Task) is due to the exercise of inhibitory control abilities as inspired by Green's (1998) model. Their argument stemmed from observations of inconsistent results for executive control abilities, which seem to appear only under certain conditions. For example, the bilingual advantage in executive control seems to dissipate after a few trials of practice in the flanker task, and it is more pronounced in middle and

older age populations because young adults are at the peak of executive function, as argued in Bialystok, Martin and Viswanathan (2005).

For example, Colzato and colleagues (2008) reported on one of their experiments measuring executive control abilities between young monolinguals and bilinguals' specific performance on a Stop signal task. Participants were instructed to press a corresponding key that matched the direction of a green arrow on the screen. Throughout the task, the green arrow alternated to red, in which case, the participants had to stop and not respond. This stop response required inhibition from the participants. Their results for the experiment with the Stop signal task indicated no significant differences between monolinguals and bilinguals' performance.

In a series of three experiments conducted in the United States, Paap and Greenberg (2013) reported on findings from college-aged bilingual and monolingual participants who completed three cognitive tasks designed to tap into executive control—Simon task, an antisaccade task and a flanker task. The Simon task was similar to the versions reported above in that the incongruent trials consisted of the location of the stimulus not matching the corresponding key that the participant was instructed to press. For the antisaccade task, participants were told to identify a target stimulus by pressing a corresponding key, which in this study were the letters "B," "P," or "R." Participants needed to rely on executive control for the trials when a distractor stimulus (the number "8" in this study) was presented before the target stimulus on the opposite side. The flanker task consisted of five arrows pointing to the left or right in the center of the computer screen. The incongruent trials were those in which the middle arrow pointed in the opposite direction of the flankers to the side. Overall, the authors found no bilingual advantage for any of the three attentional control tasks, particularly when both groups of participants were matched for SES as operationalized by parents' education level. In fact, the authors reported a bilingual disadvantage for the Simon task. That is, the monolingual participants were significantly faster at solving conflicting information than the bilingual participants.

Summary of the Literature

As the literature above suggests, the bilingual advantage is not always replicated across studies, leading some researchers to doubt the existence of a bilingual advantage for executive control in non-linguistic cognitive tasks (Colzato et al., 2008; Paap & Greenberg, 2013). This appears to be especially true among young adults, whose cognition is at its prime, and so it remains unclear whether an early bilingual experience bolsters cognition in this stage of life (Bialystok et al., 2005). Furthermore contributing to the lack of replication is the fact that the studies reviewed employed a number of different cognitive tasks to gauge inhibitory control abilities, as scholars argue that different cognitive tasks intended to measure executive functions can certainly be confounded with other underlying cognitive processes, resulting in inconsistent findings across studies (see Valian, 2015).

Last but not least, a potential explanation of special concern for the current study is that bilingual experiences are constrained by sociolinguistic environments leading to different bilingual outcomes. Kroll and Bialystok (2013) have echoed that the bilingual experience of individuals is a complex one and its interaction with executive functioning needs to be further explored. Also

of relevance, Green and Abutalebi (2013) propose that bilingual speakers differ as far as their patterns of language use in their environment (e.g., dual-language context versus code-switching context). These differences can affect the development of specific brain circuits that ultimately lead to a variation of cognitive abilities (e.g., inhibition or goal maintenance). We have argued before (Sanz, 2000) that different sociolinguistic contexts may afford individual bilingual speakers with different opportunities to exercise and develop both of their languages. Thus, a need exists to carefully screen for differences in bilingual experiences and how they can potentially shape cognition.

In the U.S. context, , it is accepted that heritage language users' experience with their home/community language, a minority language, in conjunction with the acquisition of English (i.e., the majority language) leads to linguistic outcomes in the HL that deviate from the monolingual norm (Benmamoun et al., 2013). This is especially true for those HL bilinguals who do not have the opportunity to participate in a bilingual education program that supports biliteracy and HL maintenance. This is important, as evidence suggests that biliteracy in two languages leads to cognitive benefits in children (see Bialystok, 2013), and biliterate school-age adolescents are better equipped to learn an additional language (Sanz, 2007). However, little is known as to whether the bilingual advantage extends to young adult HL bilinguals who completed their education in mainstream English-only programs and who, as a result, are limited to exposure and use of the HL in the household or local community.

To address this issue, this ongoing study is a conceptual replication of Costa, Hernández, and Sebastián-Gallés (2008), who found bilingual advantages for their young adult Catalan-Spanish bilinguals vis-à-vis Spanish monolinguals using an Attention Network Task (ANT); however, our study examines Spanish-English HL bilinguals in a U.S. context. Therefore, the following section is dedicated to the description of the study.

Costa, Hernández and Sebastián-Gallés (2008)

Costa and colleagues (2008) sought to provide more evidence for potential advantages in inhibitory control for young bilingual speakers who are at their cognitive peak, since studies have shown stronger findings for children and older adults.

They also aimed to further tap into subcomponents of attentional networks (i.e., alerting, orienting and executive control) and examined how these may be moderated by bilingual experience. Due to space constraints, this paper only reports on the results for the executive network and so we will limit our discussion to those results. While the Attentional Network Task (ANT) also measures the role of cues in directing attentional resources, we will report those data at a later time, as it would require additional literature on the alerting and orienting attentional networks. The purpose of this study is to present the first results of this ongoing study exclusively on the executive component without the intervention of cues.

The researchers employed the ANT (Fan, McCandliss, Sommer, & Posner, 2002), which is comprised of the combination of a flanker and antisaccade task, as an alternative to the Simon task. The study reported on data from 200 participants, 100 of whom were highly competent

simultaneous Catalan-Spanish bilinguals who had graduated from dual language immersion programs, had completed the university entrance exams in both Spanish and Catalan and used both languages in everyday life, and 100 monolingual Spanish speakers. Participants' ages ranged from 19 to 32 for the bilingual group and 17 to 32 for the monolingual group.

The stimuli for the ANT task consisted of a row of five black horizontal lines with the arrowhead pointing to the right or left. Participants were instructed to focus on the middle line and press a key on the computer with their left hand if the arrowhead pointed to the left and with their right hand if it pointed to the right. The flanker component of the ANT consisted of three types of stimuli: neutral, congruent and incongruent trials. In the neutral trials, the non-central lines (i.e., the four other horizontal lines along the side of the target line with the arrowhead) did not have arrowheads; for the congruent trials, the middle arrowhead pointed in the same direction as the other four arrowheads whereas for the incongruent trials, the middle arrowhead pointed in the opposite direction of the four flankers. Participants completed a series of three blocks with a short break in between each block.

Results of the study provided evidence of significant advantages for the bilingual group in all three dimensions of executive networking. To determine conflict effects, the difference between the average reaction times for incongruent versus congruent trials was calculated. The authors reported a significant triple interaction for group of participants, conflict effects and block. Subsequent analysis revealed that the bilingual participants responded significantly faster when resolving conflicting information than their monolingual peers in the first two blocks of the ANT. That is, participants in the bilingual group were more efficient at resolving conflicting information from flankers that pointed in the opposite direction. This finding replicates results from other studies that have found a bilingual advantage. The authors also examined switching cost effects to congruent or incongruent trials since bilinguals' experience also entails switching between both languages. They found that the bilingual participants were significantly faster than the monolinguals at switching to the congruent trials, but both groups performed similarly on switching to incongruent trials. The researchers explain this finding as reflecting differences in proficiency, since studies with lower proficient bilinguals have demonstrated that it takes longer to switch from the L2 to the L1, because it takes more cognitive effort to inhibit the L1. The monolingual participants were slower at switching to congruent trials because they had to recruit "more executive control" to solve the conflicting information on the incongruent trials. Overall, the authors concluded that the bilingual experience does have an effect on different cognitive domains as demonstrated by the results for both solving conflicting information and in the costs of switching attention.

Therefore, the purpose of the current study is to investigate whether young adult simultaneous HL bilinguals also demonstrate a bilingual advantage in their performance on the ANT task, specifically, for the executive network component. Their performance is compared to late

classroom emerging bilinguals of Spanish who differ in age, context of acquisition, and the length and intensity of their bilingual experience. Based on the results from Costa et al. (2008) and given HL bilinguals' early and more prolonged bilingual experience, we hypothesize that HL

participants will demonstrate superior performance on the ANT vis-à-vis the late classroom emerging bilinguals.

METHODS

Participants

A total of 48 participants, of whom 25 were HL bilinguals (HL group) and 23 late classroom emerging bilinguals (L2 group), met the criteria for participation in the current study. Most were recruited from a medium-size public university in upstate New York. The HL group consisted of 16 females and there were 14 females in the L2 group. Both groups differed significantly in age of acquisition and frequency of use of Spanish. The average onset age for Spanish for the HL group was 1,2 (*SD* = 1.7) years old, and for the L2 group was 12,9 (*SD* = 3.2). Participants rated the frequency of their daily use of English and Spanish using a six-point Likert scale (Always to Never), and questions ranged from their language use with family members and friends to various settings as school and work. A composite score was tallied for each participant, and the mean score was calculated for each group and by language. As expected, Table 1 shows that all participants reported using English much more frequently than Spanish; however, HL speakers' use of Spanish was greater than that of their L2 peers.

To examine proficiency in Spanish, self-ratings as well as scores on a modified version of *Diploma of Spanish as a Foreign Language* (DELE) test were used, following previous studies (e.g., Montrul, 2005). For the self-ratings, participants indicated their level of fluency in English and Spanish based on a six-point scale ranging from beginning to native. Results revealed that both groups of participants rated their English skills as native or near-native. In Spanish, most HL bilingual participants rated themselves as advanced in reading, writing, and speaking, and as native in listening. The L2 speakers rated themselves as intermediate in all skills. The DELE consisted of a fill-in-the-blank vocabulary test and a cloze passage. The results indicated an average score of 32.5 (*SD* = 7.1) out of a possible 50 points for HL bilinguals and 25.2 (*SD* = 7.1) for L2 speakers. Both subjective and objective measurements revealed that HL speakers were more proficient in Spanish than the L2 speakers. All participants reported not having studied in any type of bilingual education program.

Table 1.

Summary of Participant Information

	HL speakers (n=25)	*L2 speakers (n=23)*
Gender	16 females	14 females
Age		
Average Age	20,0 (1.8)	19,8 (.88)
AO English	3,9 (3.1)	1,5 (2.4)
AO Spanish	1,2 (1.7)	12,9 (3.2)

Education		
Years of formal Spanish Study	4,1 (2.4)	5,6 (2.3)
Table 1 (continued)		
Studied in a bilingual (dual or full immersion program)	No (n=25)	No (n=23)
Language Use		
Use of English	60.1 (7.0)	68.3 (10.1)
Use of Spanish	32.5 (13.3)	12.9 (8.4)
Proficiency		
Self-Rated Proficiency		
English: Speaking	5.6 (.73)	5.9 (.19)
English: Reading	5.7 (.63)	5.9 (.37)
English: Writing	5.5 (.91)	5.9 (.56)
English: Listening	5.7 (.63)	5.9 (.18)
Spanish: Speaking	4.7 (.93)	2.5 (.69)
Spanish: Reading	4.8 (1.0)	3.1 (.58)
Spanish: Writing	4.0 (1.4)	3.2 (.72)
Spanish: Listening	5.3 (.89)	3.0 (.72)
DELE	32.5 (7.1) *Intermediate*	25.2 (7.1)** *Low*

Note. (Standard Deviation) ** $p < 0.001$

Additionally, in an effort to control for potential confounding variables, an exit questionnaire was included to gather information on SES, hours spent at the computer, frequency of video gaming as well as AD(H)D diagnoses, and this information was used for sampling purposes. Table 2 shows that participants in both groups were comparable along these parameters, as follows: (1) only participants that had been raised in working class families were included; none of the participants had a parent or caretaker with a job requiring any level of college education; (2) participants diagnosed with AD(H)D, a condition that affects executive control functioning, were not included; (3) both groups did not differ in the number of hours spent at the computer or playing video games, an important variable to control given the nature of the ANT task, as described below.

Table 2.

Potential Confounding Variables

	HL (n=25)	**L2 (n=23)**
Socioeconomic Status	Working Class	Working Class
Hours on computer	4.68, SD = 1.4	4.44, SD = 2.1
Frequency of computer and video game use	19.1, SD = 4.0	18.33, SD = 3.6
Diagnosed with AD(H)D[1]	NO (n=25)	NO (n=23)

Note. SD (Standard Deviation) [1]Attention Deficit (Hyperactivity) Disorder

Attentional Network Task (ANT)

To measure executive control, participants completed the ANT as developed by Fan, McCandliss, Sommer, and Posner (2002), and employed by Costa and colleagues (2008) to study bilingual advantages on different components of the attentional system. The ANT task is a more inclusive measurement of networks of attention in that Fan and colleagues combined Posner and Petersen's (1990) cue alerting time task and Eriksen and Eriksen's (1974) flanker task (refer to Figure 1 for visual representations of each task). Participants completed a total of three blocks with 8 trials per block. The combinations of cue type (no cue, center cue, double cue, spatial cue) and flanker type (neutral, congruent, incongruent) led to a total of 12 events or conditions. Twelve conditions x 8 trials give a total of 96 trials per block. Moreover, to avoid giving participants an advantage over predicting the timing of a subsequent stimulus, the inter-trial interval (ITI) was jittered to 400ms, 1000ms and 1600ms. Participants received instructions to focus on the fixation point in the center of the screen and to respond by pressing a computer key (i.e., "z" key for left and "/" key for the right) as quickly and accurately as possible according to the direction in which the center arrow was pointing. A training phase of 10 stimuli was presented before the experimental stimuli, and both types of stimuli were presented through SuperLab 4.0 on an Apple computer. The neutral trials of the experiment consisted of two lines on each side of the middle arrow; the congruent trials consisted of flankers pointing in the same direction as the center arrow, while the flankers in the incongruent trials pointed in the opposite direction of the center arrow (refer to Figure 1). The data reported below only focuses on the *no cue* condition because the purpose of this paper is to present preliminary data, as the study is still ongoing. Furthermore, most of the studies in this area focus on the executive component of attention. Data on the alerting and orientation attentional networks will be presented and discussed in a future paper.

Figure 1. Stimuli for the ANT (Flanker component)

Neutral trials	(a). — — → — —	(b). — — ← — —
Congruent trials	(a). → → → → →	(b). ← ← ← ← ←
Incongruent trials	(a). → → ← → →	(b). ← ← → ← ←

Data Trimming and Bin Scoring Method

Reaction times (RTs) and accuracy scores for each trial for the *no cue* condition were gathered from an output report sheet produced by SuperLab 4.0 for each participant. The RTs and accuracy scores served as the dependent variables for this study. Overall, mean accuracy scores and standard deviations (SD) per group across the three trials are presented in Table 3. Regarding the RT data, any RTs that exceeded 3.0 SDs above the mean RT for each trial type were eliminated to control for outliers. Table 4 summarizes trimmed average RT and SD per trial across blocks for each group. The difference between the mean RT of the incongruent and congruent trials was calculated to determine conflict effects. Also, following Costa et al., switching cost effects were computed by subtracting the average RT for neutral trials from both incongruent and congruent trials.

The difference for each trial was further scored following a bin scoring method proposed by Hughes, Linck, Bowles, Koeth and Bunting (2014). This bin scoring method is an alternative to traditional scoring methods that do not include eliminated RT scores from inaccurate trials in the final analysis. Instead, the bin scoring method includes both accuracy and RT scores in the analysis with the goal of increasing the validity and reliability of the results.

The RT scores from accurate trials obtained from the calculation for conflict and switching cost effects were ranked from smallest to largest and then placed into a score bin. A total of ten score bins, with assigned values of 1 through 10, were created, and RTs were placed into each score bin according to where they fell along the decile rank. That is, the first decile of RT scores were assigned to Score Bin 1, the second decile to Score Bin 2, and so on. This led to the smallest RT scores to be placed in a lower value score bin, and the highest RT scores in a higher value score bin. An eleventh score bin with a value of 20 was created for RT scores from inaccurate trials. For each participant per block, a final bin score was calculated by first multiplying the number of scores assigned to each score bin by its value. For example, if a participant had 3 scores assigned to bin 7, the score for that bin would be 21. Then all the computed bin scores were summed for a final score. The mean for final bin scores per block and group are presented in Table 5. To calculate reliability of the results, final bin scores were submitted to a Cronbach's alpha analysis, yielding a = .77, which is within the acceptable range for reliability.

Table 3.

Mean Accuracy Scores

	Congruent trials	**Incongruent trials**	**Neutral trials**
HL speakers (n=25)	22.2 (3.3)	21.5 (3.5)	22 (3.3)
L2 speakers (n=23)	23.2 (2.4)	22.3 (2.6)	23.2 (2.4)

Note. Mean score (Standard deviation)

RESULTS

To investigate whether HL bilinguals demonstrated superior performance on the executive network component of the ANT, their performance was compared to that of late classroom emerging bilinguals. First, mean scores for accuracy were examined (see Table 3) and submitted to a Repeated-Measures Analysis of Variance (ANOVA) analysis, with trial type (i.e., congruent, incongruent, neutral) as the within-subjects factor and bilingual group (i.e., HL, L2) as the between-subjects factor. Due to a violation of Sphericity ($p = .012$), the data were analyzed under Huynh-Feldt, which yielded no significant differences for trial type and bilingual experience, $F < 1$, $p = .534$. These results show that both groups were comparable in their accuracy scores for each trial type.

Second, the descriptive statistics of Table 5 indicate that the HL group showed lower bin scores for conflict effects and switching effects from incongruent to neutral trials across the three blocks. With the exception of block 1, HL participants also had lower bin scores for switching from neutral to congruent trials. To determine whether these differences between the HL and L2 groups were significant, a Repeated-Measures ANOVA was conducted with bin scores (conflict effects, cost effects I, cost effects II) as within-subjects factor and bilingual group (HL, L2) as the between-subjects factor. No significant interaction was found between bin scores and bilingual group, $F < 1$, $p = .583$, *partial* $n^2 = .015$, power = .225. These results demonstrate that the overall performance between HL and L2 group on the ANT was comparable.

Third, given that Costa and colleagues only found differences between their bilinguals and monolinguals for the first two blocks of the ANT, an additional analysis was conducted to examine performance on each block for conflict and switching cost effects. A one-way ANOVA was conducted with block as factor for conflict effects, cost effects I and cost effects II. No significant results emerged for block across all conditions. That is, for conflict effects, $F(5, 697) = 1.47$, $p = .202$; for cost effects I, $F(5, 706) = 1.47$, $p = .204$; and for cost effects II, $F < 1$, $p = .863$.

Unlike the results in Costa et al. (2008), whose Catalan-Spanish bilingual participants demonstrated significantly lower costs in their performance on the ANT, the results here indicate that the performance between both HL bilinguals and late classroom emerging bilinguals was

parallel across the three blocks. In sum, these first results suggest that no differences exist in executive control abilities between the HL and L2 groups.

Table 4.

Mean RT Scores

	HL Speakers (n=25)			**L2 Speakers (n=23)**		
Block	*Congruent*	*Incongruent*	*Neutral*	*Congruent*	*Incongruent*	*Neutral*
1	634 (88)	710 (84)	628 (85)	597 (76)	707 (117)	609 (87)
2	611 (60)	730 (92)	581 (67)	601 (83)	681 (101)	581 (67)
3	596 (77)	708 (97)	582 (70)	581 (70)	678 (70)	587 (66)

Note. Mean score (Standard deviation)

Table 5.

Mean Bin Scores per Block and Group

	Conflict Effects incongruent - congruent		**Cost Effects I** (switching to incongr) incongruent - neutral		**Cost Effects II** (Switching to congr) neutral - congruent	
Block	*HL*	*L2*	*HL*	*L2*	*HL*	*L2*
1	43.8 (8.8)	49.3 (8.4)	44.7 (11.2)	49.1 (8.4)	44.0 (12.2)	43.3 (2.7)
2	44.0 (11.6)	48.2 (8.0)	44.4 (9.1)	48.2 (8.0)	42.7 (8.2)	44.9 (5.7)
3	45.4 (11.4)	48.5 (9.2)	45.4 (11.8)	48.7 (8.9)	44.3 (10.7)	45.5 (5.5)

Note. Mean Score (Standard Deviation)

DISCUSSION

This paper presents the first results of an ongoing research study that investigates executive control abilities among simultaneous young adult HL bilinguals vis-à-vis late classroom emerging bilinguals of Spanish in a U.S. context. Given the mixed results produced by the literature on the bilingual advantage and the role of societal factors in determining individual bilingual outcomes, the goal of this research was to extend the investigation of the bilingual advantage to a group of HL bilinguals of Spanish living in the U.S., where Spanish is a minority language. Based on previous research, the current study hypothesized that HL bilinguals would demonstrate superior performance on the ANT because of their longer bilingual experience, however, our results do not support such hypothesis. These results are in line with Colzato et al. (2008), Paap and Greenberg (2013) and the young adults in Bialystok et al. (2005), who also found no differences between early bilinguals and monolinguals; our results do not replicate those in Costa et al. (2008) who also used an ANT task.

In order to understand these apparent contradictions, we need to understand that the young bilinguals in Costa et al. had graduated from bilingual schools and completed college entrance

exams in both languages; they were therefore highly functional bilinguals who used both languages very frequently in academic contexts. In contrast, the U.S. Latino participants in our study are English-Spanish HL bilinguals whose experience with bilingualism in terms of schooling, level of proficiency and frequency of use of the minority language differs in significant ways from the Catalan-Spanish bilinguals in Costa et al. due to the different sociolinguistic situations that frame their individual experience as bilinguals.

Despite the strong presence of Spanish in the United States, heritage Spanish bilinguals grow up in a society that does not promote additive bilingualism. In fact, U.S. immigrants become mostly English monolinguals by the third generation (e.g., Rivera-Mills, 2012; Fishman, 1964). The situation differs from that in Catalonia, where linguistic and educational policies in place since the 1980s have promoted bilingualism and biliteracy through education (Sanz, 2000). These differences in societal bilingualism have an impact on individual bilingualism, as some contexts but not others provide equal opportunities for substantial use of both languages, the necessary requirement to exercise executive control mechanisms. Potentially, then, variation in language use by individual speakers can affect the amount of switching between both languages, which can itself alter cognitive outcomes, as researchers posit that it is the switching between both languages that may be the cause for developing superior executive control abilities (Green & Abutalebi, 2013).

Given that our HL bilinguals did not attend an early dual language immersion or other type of bilingual program, they lacked early academic exposure to the HL, which makes their bilingual experience qualitatively different from the participants in Costa et al.'s study. Consequently, this lack of early bilingual education leads not only to unbalanced proficiency, but also affects the amount of language use and switching between languages. In fact, recent research has documented that monolingual children who enroll in bilingual education programs demonstrate a bilingual advantage in cognitive tasks after a short period of time (Nicolay & Poncelet, 2013, 2015). The nature of bilingual education programs in which students are developing literacy and academic skills in two languages, which routinely requires executive control, may contribute to the necessary language switching patterns that lead to substantial behavioral differences in cognitive tasks. However, whether the experience of having attended a bilingual education program confers an additional cognitive advantage for young adults remains an empirical question, as the bilingual advantage in young adulthood is not as pronounced as in children and older adults (Bialystok et al., 2005).

It is important to point out that the current study has not produced evidence that favors a bilingual disadvantage in executive control: we have not found, as Paap and Greenberg (2013) found for their Simon task, that the monolingual group outperformed the bilingual participants. In fact, the data trend suggests overall that HL bilinguals demonstrated lower costs in solving conflicting information and switching trials, albeit the results were not significant. Therefore, while both the current study and Paap and Greenberg tested U.S. bilinguals, we did not find a bilingual disadvantage in our results, perhaps due to slight differences between the Simon and ANT tasks. As Valian (2015) argued, cognitive tasks vary as far as the number of executive control processes they measure, and often including a confluence of other cognitive processes in

the same task. For instance, Costa et al. (2008) highlight that the Simon task requires a working memory component because participants must maintain the instructions to complete the task regarding the color and its corresponding key, a feature not part of the ANT.

In fact, we propose that the explanation for the differences in effects—negative (Paap et al., 2013), neutral (present study), or positive (Costa et al., 2008) may lie in the interaction amongst differential task requirements and proficiency in and use of the two languages. Specifically, the current study examined Spanish simultaneous heritage bilinguals whose dominant language is English and who have not benefitted from bilingual education, whereas Paap et al. (2013) reported three subcategories for their bilinguals (i.e., native in English and in the other language; native in the other language but not in English; and native in English but not in the other language). Their criterion to distinguish among these three groups is solely based on age of acquisition. However, the authors do not report on the educational level of these bilingual speakers; moreover, the percentage of English use for the "native in both languages" group is sometimes higher or the same as the other subgroups. Frequency and context of use are not reported. This is all highly problematic, as native bilingualism is not equivalent to native competence in both languages, as research on language attrition has shown for individuals who live in a sociolinguistic context that does not support HL maintenance. This is most probably the case in Paap et al.'s study, whose sample lived in the United States. Therefore, although the authors claim that their criteria for selecting their sample fit those in Bialystok's Canadian studies, they in fact do not take into account the sociolinguistic context of their participants, which differs from those in Canada or Catalonia, in that the U.S. is not officially bilingual and does implement bilingual education programs. Again, there is much more to being bilingual than age of acquisition: proficiency, frequency and context use, and biliteracy, are all factors influencing bilingualism at any given time in the bilingual's life.

Along these lines, Kroll and Bialystok (2013) have argued that researchers need to take into account that the bilingual experience "must be studied in the context of a dynamically changing system of linguistic and cognitive performance, an approach that extends beyond categorical assignments to groups" (p. 501). Luk and Bialystok (2013) cautioned against reductively operationalizing bilingualism as a categorical variable (i.e., monolingual vs. bilingual), instead of viewing the experience as a continuum. Therefore, the authors claimed that it is necessary to capture different bilingual experiences to understand the complexities of such experience.

As such, the current study captured the specific bilingual experience of simultaneous HL speakers of Spanish, a minority group in the U.S. The exponential growth of the Latino population in the United States and the constant presence of first generation immigrants (Beaudrie & Fairclough, 2012) give Spanish a more prominent status in comparison to other heritage languages. Still, the sociolinguistic context for U.S. Latinos is characterized by a significant reduction in opportunities for the use of the minority language and by the absence of bilingual education programs, resulting in lack of literacy in the HL and ultimately attrition. At the societal level, attrition results in specific patterns of language change (Benmamoun et al., 2013); at the individual level, unbalanced proficiency and use, as well as a lack of literacy skills in the HL, prevent HL bilinguals from gaining the cognitive edge associated with bilingualism in

other bilingual populations. In conclusion, these findings demonstrate how societal bilingualism constrains individual bilingualism and the consequences for bilingual cognition.

Conclusion and Future Research

This paper reported the first findings of an ongoing research project on the cognitive control abilities of simultaneous heritage Spanish bilinguals. The aim of the project is to investigate whether the linguistic experience that characterizes heritage bilinguals as determined by their specific societal context confers the same executive control abilities on nonlinguistic cognitive tasks (e.g., ANT) that have been reported for a bilingual population in Catalonia (Costa et al., 2008). Overall, results do not replicate the findings from Costa and colleagues, in that they revealed no significant differences between the HL and late classroom emerging bilinguals in their performance on the ANT. Importantly, however, we did not identify any negative effects either. Significant key differences between the populations and their sociolinguistic context explain these apparently contradicting results. Specifically, the bilinguals in Costa et al. had graduated from a system that adheres to principles guiding the design and implementation of a sound bilingual education program.

Further research is necessary as other reasons may explain the lack of significant differences in our study, the most important being the small number of participants and the age of the sample. Both groups were made up of young adults at their cognitive peak, making it difficult to see possible advantages derived from experience with language, typically found in children and in aging adults. It also remains to be seen how the manipulation of cues in the ANT task that tap into the alerting and orienting attentional networks influence the performance of participants in resolving conflicting information and switching between trials. Looking ahead, our main interest is to investigate a continuum of different bilingual experiences in the U.S. context, and for that, in addition to recruiting more participants, we will also include in the project HL bilinguals who are graduates of dual language programs.

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