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# Measuring the Effects of Acculturation on Different Types of Memory in Spanish Speaker

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TRINITY COLLEGE

MEASURING THE EFFECTS OF ACCULTURATION ON DIFFERENT TYPES OF  
MEMORY IN SPANISH SPEAKERS

BY

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A THESIS SUBMITTED TO THE FACULTY OF THE NEUROSCIENCE PROGRAM IN  
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Measuring the Effects of Acculturation on Different Types of Memory in Spanish Speakers

BY

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## Introduction

Studies show that minorities are more likely to be misdiagnosed as neuropsychologically impaired than non-Hispanic whites due to artificially depressed neuropsychological test scores (Arentoft et al., 2012). One aspect to consider as a possible factor is acculturation (Arentoft et al., 2012). Acculturation is the process of psychological and behavioral changes that occur due to prolonged contact with another culture (Zea et al., 2003). Previous studies have found acculturation into U.S (dominant) culture is correlated with better neuropsychological performance on a variety of neuropsychological realms, such as information processing (Razani et al., 2007) and working memory (Coffey et al., 2005). Latinxs are a growing population in the U.S, increasing by 1,131,766 between 2015 and 2016 (U.S. Census Bureau, 2017). Therefore, it is important to recognize any effects that acculturation may have on Latinx individuals as findings can help assess, treat and diagnose this rapidly expanding population. The present study will look at the effects of acculturation on different types of memory in Spanish speakers by correlating performance on neuropsychological assessments of working, prospective and autobiographical memory as well as future thought with degree of US acculturation.

## Culture

Cultural differences can have an effect on the way individuals experience the world, however, it can also impact their cognitive function and neuropsychological test performance. The effect of cultural differences on neuropsychological test performance have been mainly studied by comparing eastern and western cultures, where discrepancies have been observed (Ogden & MacFarlane-Nathan, 1997). However, increasing evidence has been established revealing sociocultural factors play a significant role in neuropsychological test performance discrepancies between racial minorities and non-Latinx whites, where minorities significantly

underperform compared to their counterparts (Saez et al., 2014). When assessing minority groups (Hispanic, Asian and Middle-Eastern descent), a study by Razani et al. (2007) found that monolingual English-speaking Anglo-Americans consistently outperformed the ethnically diverse counterparts. More importantly, this study by Razani and colleagues (2007) also found a correlation between performance on common information processing and attention assessments and higher acculturation variables apart from language, such as time educated in the U.S. and amount of English spoken when growing up. These findings indicate effects of acculturation on cognition related to both language and non-linguistic cultural factors. Similar findings were observed in Latix individuals specifically; when assessing effects of acculturation in HIV+ Latina/o individuals, Arentoft and colleagues (2012) found that higher US acculturation scores were associated with better overall neuropsychological, verbal fluency, processing speed and attention. This same study also found lower Latina/o acculturation was associated with better executive function and learning, higher Latina/o acculturation was correlated with better memory performance (Arentoft et al., 2012).

## **Language**

Language for bilinguals functions as a dynamic system where the primary (L1) and secondary (L2) language are simultaneously active, indicating a competition between the two languages for cognitive resources (Kroll et al., 2014). Based on the Inhibitory Control Model, this competition is resolved by active inhibition of the language not in use, although the process that underlies the selection of the appropriate language is not clear (Durlak et al. 2016). In a study by Macizo et al. (2010), Spanish-English bilinguals were asked to decide whether pairs of English words were related, some of the words were interlexical homographs meaning they share the same spelling across languages but different meanings. The study found bilinguals inhibited

the unrelated homograph meaning to the words, suggesting an inhibitory language selection system is present in bilinguals (Macizo et al., 2010). It is possible that the more dominant language (L1) is substantially inhibited compared to the non-dominant language (L2) (Guo et al. 2011). A study found that the degree of co-activation in bilingual word comprehension depends on the amount of daily exposure to the non-target language; they also found bilinguals with less cross-language activation influence may be more efficient in suppressing interference in non-linguistic task (Chen et al., 2017). Two types of inhibition mechanisms have been proposed regarding language suppression: global and local control (Guo et al. 2011). Global control inhibits and/or activates the complete language system, whereas local control only controls a set of memory representations (Guo et al. 2011). These two types of inhibition exhibited distinct neural activation patterns, global inhibition showed activation in the dorsal left frontal gyrus and the parietal cortex, while local inhibition showed activation in the dorsal anterior cingulate cortex and the supplemental motor area (Guo et al. 2011).

Disparities in memory have been found between bilinguals and monolinguals. When comparing monolingual and bilingual children's performance on tasks requiring different levels of working memory, bilingual children out performed monolingual children especially in tasks with additional executive function demands (Morales et al., 2013). Similar results were found regarding episodic memory; when presented with a picture scene recall task, researchers found older adult bilinguals had better episodic memory than their monolingual counterparts (Schroeder & Marian, 2012). Additionally, bilingual older adults also had better executive functioning than their monolingual counterparts (Schroeder & Marian, 2012). Kormi-Nouri et al. (2003) presented monolingual and bilingual children with performed and verbal tasks with retrieval, as well as word fluency tests as means of testing episodic and semantic memory

respectively. The researchers found bilingual children significantly outperformed their monolingual counterparts in both types of memory assessments (Kormi-Nouri et al., 2003).

Research has also been conducted to analyze the effects of bilingualism on the brain. A study found two neural sub-networks with higher white matter tract concentration in bilinguals compared to monolinguals (García-Pentón et al., 2014). The first of these encompasses the left frontal and parietal/temporal regions, which seem to be involved in phonological and semantic interference between the two languages (García-Pentón et al. 2014). The second comprises the left occipital and parietal/temporal regions and the right superior frontal gyrus which seem to regulate word recognition, reading and semantic processing (García-Pentón et al. 2014). These two networks seem to be strengthened in bilinguals in order to fulfill language demands and to control the use of both languages (García-Pentón et al. 2014). Additionally, functional magnetic resonance imaging (fMRI) studies found greater anterior cingulate cortex activation for monolinguals than bilinguals when resolving nonlinguistic conflict resolution tasks; suggesting that bilinguals are more efficient at using this brain area related to conflict resolution, attention allocation and decision-making than monolinguals (Abutalebi et al., 2012). The researchers concluded that bilingualism “tunes” the anterior cingulate cortex (Abutalebi et al., 2012). This enhanced control of anterior cingulate cortex function in bilinguals may cause enhanced performance on neuropsychological assessments that involve attention allocation and decision-making, such as the Memory for Intention Screening Test (MIST) used in this study.

## **Memory**

### Working Memory

Working memory is the system involved in temporary maintenance of information, which may include cognitive tasks such as reasoning and comprehension (Baddeley, 2010). Working

memory is critical for mediating conscious interactions with the world (Ricker et al., 2010). It is critical for cognitive function as it holds information that is being processed in an available state, therefore, it affects how humans think about and resolve problems (Ricker et al., 2010).

Working memory is comprised of several systems including the central executive, the phonological loop and the visuospatial sketchpad (Baddeley, 2002). The central executive is the control system that is responsible for control and regulation of cognitive processes; the phonological loop and the visuospatial sketchpad serve as “slave systems” to the central executive (Baddeley, 2001). The phonological loop is associated with short-term verbal recall, where the traces in the phonological store decay in a period of about two seconds unless it is rehearsed by the articulatory rehearsal system (Baddeley, 2001). The phonological loop allows fast recall of items such as phone numbers that may be forgotten quickly if they are not rehearsed (Baddeley, 2001). The third system, the visuospatial sketchpad, integrates visual and spatial information from the senses or long-term memory (Baddeley, 2001). The visuospatial sketchpad mainly facilitates spatial orientation however, it also promotes the solution of visuospatial problems (Baddeley, 2001). Both the phonological loop and the visuospatial sketchpad are under the control of the central executive, which administrates critical functions such as focused attention and switching attention (Baddeley, 2001). Episodic buffer is the last component of working memory, it is a temporary storage system that can integrate information from the phonological loop and the visuospatial sketchpad (Baddeley, 2000). This buffer is also controlled by the central executive and conscious awareness appears to be the method of information retrieval from the buffer (Baddeley, 2000).

Neuroimaging studies suggest that the main area related to working memory control function is the frontal lobe (Ricker et al., 2010). The intra-parietal sulcus (IPS) mediates the retention of perceptual and conceptual features of memory traces (Ricker et al., 2010).



Additionally, working memory storage take place posterior cortex association areas, specifically in the parietal cortex (Owen, 2004). Culture has shown to impact performance on working memory assessments (Alea et al., in print). The frontal cortex discussed here is critical for many functions including language inhibition in bilinguals (Guo et al. 2011). Therefore, bilingualism and acculturation are possible factors modifying prospective memory performance.

### Prospective Memory

Similar to working memory prospective memory is crucial for everyday life (Crystal, 2013). Prospective memory is the ability to remember to perform a specific task at some point in the future (McDaniel & Einstein, 2000). This is type of memory that is associated with remembering to take the laundry out of the dryer once it is finished. Our intentions to act in the future are stored as memory when other interruptions displace them, allowing them to be retrieved at a later time (Crystal, 2013), hence remembering to remember. There are two types of cues that help retrieve information in prospective memory: time-based cues and event-based cues (Crystal, 2013). Time-based prospective memory is the use of a specific time as a cue for performing a task in the future. Event-based uses an event as a cue to perform the intended task. Remembering to remove an item from the oven in 15 minutes is an example of time-based prospective memory, while remembering to remove an item from the oven when the timer goes off is an example of event-based prospective memory.

Prospective memory mostly consists of top-down processing, where the activation of the intention to carry out a task is maintained in order to later perform it (McDaniel et al., 2013). The multiprocess framework theory suggests that there are a variety of methods to remember to perform a task, which depend on variables such as the importance of the task and the nature of the cues (McDaniel & Einstein, 2000). These methods include automatic (activated when cue

occurs) and active (monitoring for the presence of the cue) (McDaniel & Einstein, 2000).

Prospective memory can also be affected by external factors such as rewards, task importance and social motivation (Walter & Meier, 2014), therefore, it is plausible that acculturation may have an impact on it.

Imaging studies have revealed elucidating data regarding the neuroanatomy of prospective memory. Prospective memory has been linked to right dorsolateral and ventrolateral prefrontal cortices, left frontal pole (Brodmann's Area 10) and anterior cingulate gyrus, left parahippocampal gyrus and medial frontal lobe activation (Okuda et al., 1998; West, 2008). Some of these brain areas, such as the cingulate gyrus and the lateral prefrontal cortex, have been associated with language inhibition in bilinguals (Guo et al. 2011), raising a question of possible effects of bilingualism on prospective memory function.

### Autobiographical Memory

While prospective memory consists of remembering to perform tasks in the future, autobiographical memory encodes and retrieves personal events and facts (Fossati, 2013), this type most often comes to mind when people think of the term "memory". Autobiographical memory is crucial to self-preservation and understanding given its crucial role in event recall. Autobiographical memory is thought to develop as a part of an individual's social and cultural experience, whereby the development of language coincides with earliest memories that can be recalled (Fivush & Nelson, 2004). Additionally, autobiographical memory recall is often cued by social context and can be reconstructed so that it is in line with the individual's current goals (Alea et al., in print).

Since autobiographical memory is responsible for encoding, preserving and recalling memories, it has a complex and dispersed neural network (Fossati, 2013). The medial and lateral

part of temporal, frontal and parietal cortex and some limbic structures all play a role in autobiographical memory retrieval (Fossati, 2013; Maguire, 2001). The hippocampus, most commonly associated with learning and memory, is highly involved in autobiographical memory due to the constant encoding of events (Bonnici et al., 2018). The lateral frontal and parietal/temporal regions indicated here, are part of a neural network shown to have higher white matter tract concentration in bilinguals compared to monolinguals (García-Pentón et al., 2014). Additionally, bilinguals outperformed their monolingual counterparts in episodic memory assessments (Schroeder & Marian, 2012). These findings suggest possible greater autobiographical memory performance by bilinguals compared to their monolingual counterparts.

### Future Thought

Autobiographical memory, memories of the past, are necessary for thinking about the future. Episodic future thought is the ability to visualize future events that may occur in one's life (Atance & O'Neil, 2001). Episodic future thought is often used for motivation or incentive, such as visualization of one's goals for the future; for example, if someone has a goal to graduate from college, they may envision themselves receiving their diploma. This is most commonly observed when individuals 'day dream' or think about scenarios in the future. This kind of thinking is so prevalent that researchers estimate about one third of each waking day is spent simulating aspects of one's life (Szpunar, 2010).

Visualizing future events consists of episodic future thought, prospection, simulation and projection (Szpunar, 2010). Episodic future thought is closely related to episodic memory, if one cannot recall any events from the past, as insignificant as they may be, they may not be able to imagine events in the future (Atance & O'Neil, 2001). Additionally, episodic future thought is

closely linked to prospective memory since the memory formation of an event that's to be completed in the near future may include the visualization of the event or of the (Nigro et al., 2014).

Future episodic thought engages a broad network primarily composed of the medial temporal lobe, medial prefrontal, posterior cingulate cortices as well as parts of the parietal cortex (Benoit et al., 2011, Addis et al., 2007; Szpunar, 2010; Svoboda et al., 2006). Some of these areas were activated for episodic memory and future thought since thinking about the past is necessary for thinking about the future as was previously discussed (Addis et al., 2006; Szpunar, 2010; Svoboda et al., 2006). The medial temporal lobe is thought to mediate episodic future thought (Benoit et al., 2011). The medial prefrontal cortex is believed to play a role in memory search as well as future event formation (Addis et al., 2007). The cingulate cortex on the other hand is thought to play a role in self-reflection and autobiographical memory retrieval (Addis et al., 2007). Lastly, parietal cortex has been associated with retrieval of spatial context of events (Svoboda et al., 2006). Additionally, the hippocampus has been found to play a role in episodic future thought, this may be due to the novelty of the situations (Addis et al., 2007). Cultural differences in future thinking performance have previously been found (Alea et al., in print), therefore, it is important to study any effects acculturation may have on future thought, especially due to a gap in the literature on the matter.

As discussed previously, cultural differences and bilingualism have been shown to impact performance on working, prospective and autobiographical memory as well as future thought. It is necessary to assess the effects of acculturation on these types of memories in one study to obtain a more comprehensive understanding on the role culture and bilingualism play on neuropsychological performance. Given that the Hispanic population continues to increase

dramatically in the United States, evaluating these effects on Spanish speakers with varying degrees of acculturation is an essential task.

## **Methods**

### **Participants**

Participants were recruited through flyers, verbal invitation and online Trinity College newsletter. The requirements for participating in the study were the following: participants had to be fluent Spanish speakers, over 18 years of age and have no previous neurological or psychological disorder. Each participant received a \$10 gift card as compensation for their time. Participants ( $n=x$ ) were of ages 18- $x$ , met all the discussed criteria. One of the participants was left-handed, their data was still included in the study as this was not considered an exclusion factor.

### **Materials**

Participants completed background information form that included questions on their life inside and outside of the United States and their exposure to both English and Spanish, such as, “Were you born in the United States? If not, how long have you lived in the United States?” and “Which language do you think in?”. Participants also completed the Spanish Abbreviated Multidimensional Acculturation Scale (Zea et al., 2003). This included statements about the individuals’ relationship to American culture and their own “mother” culture such as “I feel as though I am a part of American culture”. Participants were provided with four possible answers ranging from “Strongly disagree” to “Strongly agree”.

Assessments were also administered for each type of memory being tested: working, prospective, autobiographical memory, and future thought. The Digit Span Forward (DSF) and Digit Span Backward (DSB) were used as a measure of working memory. In the DSF, the researcher reads a series of numbers to the participant, the participant then repeats as many of the

digits in the correct order as she or he can remember. The assessment uses two digits for the initial trial and increases as each trial continues. The DSB follows the same protocol, however, the participant is asked to repeat the digits back to the researcher in the opposite order of their delivery.

The assessments used for prospective memory were the translated Memory for Intentions Screening Test (MIST) and a prospective memory self-assessment. The MIST is administered by the researcher and takes approximately 30 minutes, the MIST includes simple tasks with either a 2 or 15-minute delay. While performing an ongoing task (a word search), the participant must remember to perform the task the researcher instructed them to by using either a time or event-based cue. There is also a recognition section given after the recall portion is completed. Additionally, the participant was asked to call the researcher the following day around the same time as the session as a 24-hour delay assessment of everyday memory for intentions. In the prospective memory self-assessment, the participant was asked to rate the frequency of forgetfulness of everyday events from a 1(never)-5 (very frequently/daily) scale.

The original MIST was translated and back-translated by native Spanish speakers.

The translated Thinking About Life Experiences (TALE) scale (Bluck & Alea, 2011) was used to evaluate autobiographical memory. In the TALE, the participant is asked to answer a series of questions regarding the frequency at which they recall past events for specific reasons such as “I think back over or talk about my life or certain periods of my life when I want to feel that I am the same person as before” or “I think back over or talk about my life or certain periods of my life when I want to develop more intimacy in a relationship”. Each question asks the frequency based on a specific reason and the participant is asked to choose a response between almost never, seldom, occasionally, often and very frequently.

Future thought was assessed by asking the participant to imagine an event from the following month that would occur on a single day; they were asked to describe it in as much detail as possible including who they would be with, where it would occur etc. Additionally, the participant was also asked to imagine the impact the event would have on the whole community. This was scored on a 1-5 scale for 7 characteristics of the description such as the location of the event and the description of other people present.

### **Procedure**

Testing was carried out in one session. The total testing time ranged from 45 minutes to one hour and a half. The sessions were held in a quiet office setting. The tests were counter-balanced. The results were gathered and analyzed. Breaks were given if the participant complained of fatigue.

### **Statistical Analysis:**

The results were analyzed using a Pearson product-moment correlation to assess the relationship between cognitive tests performance and US acculturation. The data was analyzed using SPSS software.

## **Results**

When performance on cognitive assessments was considered, participants with lower American acculturation performed better on the two-minute delay tasks in the translated MIST,  $r = -.416$ ,  $n = 25$ ,  $p = .035$ . Alternatively, participants with higher US acculturation performed better in the collective future thought assessment than their less acculturated counter-parts,  $r = .413$ ,  $n = 25$ ,  $p = .040$ . Similarly, participants with more years of education in the US had higher performance on collective future thought than their counterparts with lower or no education in the US,  $r = .468$ ,  $n = 25$ ,  $p = .018$ .

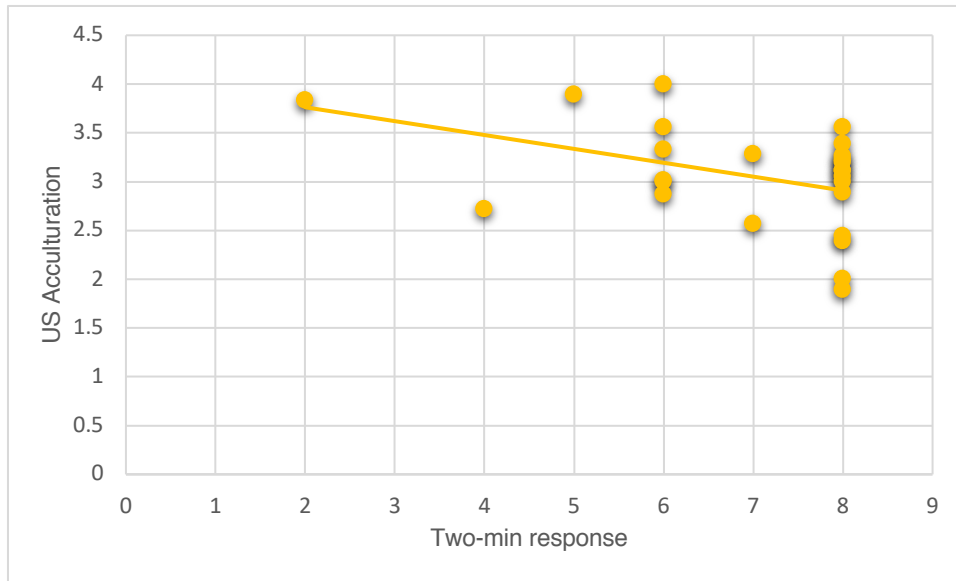


Figure 1. Correlation between US Acculturation and MIST two-minute delay scores,  $p=.035$



Figure 2. Correlation between US acculturation and collective future thought scores,  $p=.040$



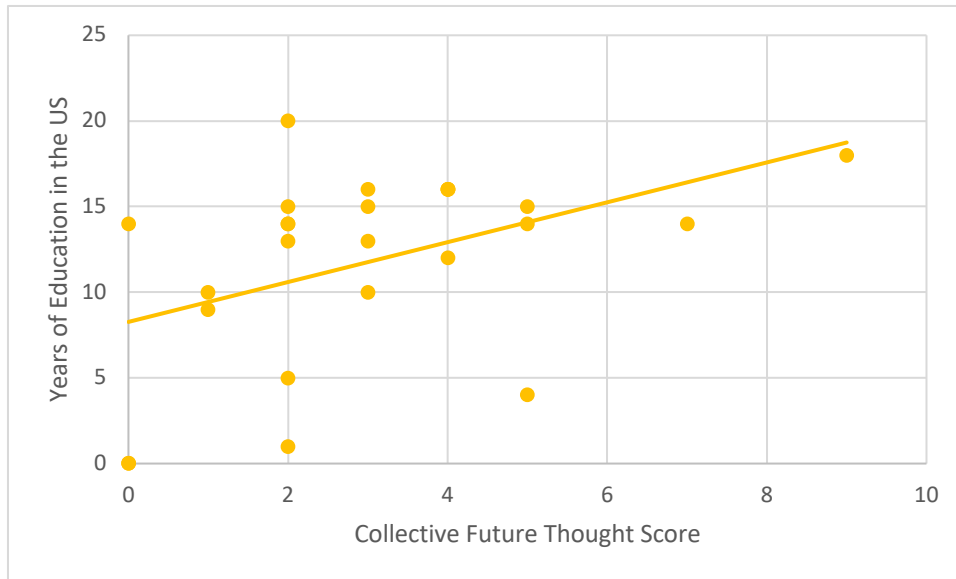


Figure 3. Correlation between collective future thought scores and years of education in the US,  $p=.018$

Table 1. Participants' demographics

N	Male	Female	Mean age	Mean years of education
25	9	16	23.24 ( $\pm 10.58$ )	14.48 ( $\pm 2.00$ )

Table 2. Spanish MIST performance mean

Item	2-min	15-min	Time cue	Event cue	Verbal	Action	Recognition	24-hour	PM error	Total error
Mean score	6.92 ( $\pm 1.55$ )	5.4 ( $\pm 1.94$ )	6.0 ( $\pm 1.32$ )	6.56 ( $\pm 1.58$ )	6.76 ( $\pm 1.33$ )	5.84 ( $\pm 1.67$ )	7.48 ( $\pm 0.65$ )	0.84 ( $\pm 0.90$ )	0.68 ( $\pm 0.75$ )	2.04 ( $\pm 1.14$ )

*Table 3.* Translated CAPM performance mean

Item	BADL score	IADL score	CAPM total
Mean score	1.53 ( $\pm 0.41$ )	2.03 ( $\pm 0.56$ )	1.84 ( $\pm 0.47$ )

*Table 4.* Translated TALE performance mean

Item	Self-continuity	Social bonding	Directing behavior
Mean score	14.88 ( $\pm 4.80$ )	17.40 ( $\pm 3.92$ )	18.60 ( $\pm 3.81$ )

*Table 5.* Digit span raw performance scores mean

Item	Forward	Backward	Sequencing	Total
Mean score	7.48 ( $\pm 1.45$ )	7.36 ( $\pm 2.15$ )	7.12 ( $\pm 1.39$ )	21.96 ( $\pm 4.08$ )

*Table 6.* Future thought performance mean

Item	Future thought	Collective future thought
Mean score	6.48 ( $\pm 3.60$ )	3.00 ( $\pm 2.14$ )

## Discussion

Our results for the present experiment showed a statistically significant correlation between US acculturation and performance on the two-minute trial of the MIST as seen in figure 1. We found, a negative correlation between these two factors, indicating lower US acculturation score was associated with better performance on the two-minute trial of the MIST. This finding did not parallel previous studies, where higher US acculturation was correlated with better

overall performance on neuropsychological assessments (Razani et al., 2007; Saez et al., 2014). As previously discussed, bilingualism “tunes” the anterior cingulate cortex, positively impacting attention allocation (Abutalebi et al., 2012). This may be a possible explanation for increased performance on the two-minute trial of the MIST. Participants with lower US acculturation, likely spend more time speaking Spanish in a private setting, creating a larger demand for alternating between Spanish and English when they are in public. This shifting would be far more consistent than would be the case for an individual with higher US acculturation, which may spend significantly less time speaking Spanish, therefore, requiring less altering between the two languages. Due to higher demand for change in the brain, it is possible that individuals with lower US acculturation levels have finer tuned anterior cingulate cortices, causing better shifts in attention allocation; consequently, performing better on assessments requiring short term attention shifts such as the two-minute trials of the MIST.

Additionally, our statistical analyses showed a statistically significant positive correlation between higher US acculturation performance on the collective future thought assessment (figure 2). This finding indicates higher US acculturation score was correlated with better performance on collective future thought. Collective future thought has not been studied in depth, however, it is known that it captures social/groups dynamics (Szpunar & Szpunar, 2016). We speculate, that the positive correlation observed between higher US acculturation and collective future thought may be caused by higher sense of group belonging. Individuals with higher US acculturation may feel a higher sense of belonging within the community when they were asked to describe an event. Oppositely, individuals with lower US acculturation may be immigrant or may not feel a sense of belonging in their community, causing more challenges when asked to describe a future event that may impact the community at large.

Lastly, our data showed a statistically significant positive correlation between number of years of education in the US and performance on collective future thought assessment (figure 3). Previous studies suggest that acculturation is related to English language proficiency (Saez et al., 2014), therefore, we speculate that individuals that had a more years of education in the US would have higher English language proficiency and acculturation. This higher acculturation relates to the finding previously discussed of higher US acculturation correlated to better performance on collective future thought.

### **Limitations and Future Directions**

The most significant limitation from this study is the sample size. Although there were some statistically significant figures from the data, a larger sample size may provide a better understanding of what the correlations are between US acculturation and neuropsychological performance. Another variation was the variability between participants regarding characteristics such as age, country of origin etc. Although some variability, especially regarding acculturation, is necessary for this research, future studies might benefit from limiting the number of variables. This can be done by testing only participants from a specific age range or cultural background. Lastly, results might be more accurate for Spanish speakers if researchers use neuropsychological evaluations specifically designed for Spanish speakers. This is due to possible flaws in using translated neuropsychological evaluations designed for a specific group for a completely different group that is from a distinctive cultural background.

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