AUTOBIOGRAPHICAL MEMORY AND AGING AMONG BILINGUAL AND MONOLINGUAL HISPANICS

By

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As members of the Dissertation Committee, we certify that we have read the dissertation prepared by Mónica C. Acevedo-Molina; titled, Autobiographical Memory and Aging in Bilingual and Monolingual Hispanics
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Dedication

Para Papi y Mami. Sin ustedes y todos sus sacrificios, no estuviese aquí. Mami, cuanto quisiera compartir este momento contigo, pero estoy segura de que estas conmigo en todo momento de alguna forma u otra. Papi, espero que sepas lo mucho que significas para mí. Sin ti, tu amor, y tu apoyo, no hubiese llegado tan lejos. Esto es para ustedes.

Table of Contents

List of Figures/Illustrations and Tables

Abstract

Background: Episodic autobiographical memory (EAM) may be particularly sensitive to age-related cognitive decline and risk for Alzheimer's disease. Virtually nothing is known about EAM specificity in Hispanic individuals. Bilingualism is a cognitive factor that may influence EAM specificity among Hispanics. Bilingualism is thought to affect executive functions, particularly inhibition, which may influence the types of details generated while recalling EAMs. The present study aimed to 1) examine if EAM is sensitive to age in Hispanics, 2) reveal whether bilingualism influences EAM specificity in Hispanics, and 3) explore the influence of inhibition on EAM specificity in this population.

Methods: A sample of 150 young and middle-aged/older adults (50 English-Spanish bilingual Hispanics; 50 monolingual English-speaking Hispanics; 50 monolingual English speaking Non-Hispanic Whites) narrated EAMs using the established Autobiographical Interview (Levine et al., 2002). Using the scoring protocol of the Autobiographical Interview, we evaluated the narratives for episodic and non-episodic detail. Bilingual and monolingual Hispanics completed a computerized version of the color-world inhibition "Stroop" test.

Results: We were able to replicate the often-found age-related reduction in episodic detail generation in Hispanics. Bilingual Hispanics' memories were more episodically specific relative to monolingual Hispanics and monolingual Non-Hispanic Whites. We also found that, among bilingual Hispanics, the language used at encoding versus language used at memory retrieval was not associated with episodic specificity. Lastly, we found that episodic specificity did not predict performance on an inhibition task and that middle-aged/older bilingual Hispanics had worse inhibition overall.

Conclusion: Our findings suggest that episodic autobiographical memory is sensitive to age and bilingualism in Hispanics, making it a culturally appropriate cognitive measure among this population.

1. Introduction

Accumulating evidence indicates that Hispanics bare a disproportionate burden from Alzheimer's Disease (AD) and are underserved by the current healthcare system (Novak & Riggs, 2004; Hebert, Weuve, Scherr, & Evans, 2013; Matthews et al., 2018). Hispanics are diagnosed with AD 1.5 times more than non-Hispanic Whites, and at a younger age. However, the disease tends to go undetected and untreated for a longer time in Hispanics, as measured by delay between onset of symptoms and diagnosis (Mayeda et al., 2016). These facts raise significant concerns for an estimated 1.1 million Hispanics in the U.S. who will be diagnosed with AD in 2030 (Alzheimer's Association, 2015). Moreover, the relationship between AD dementia and older Hispanics is characterized by a complicated dynamic between the disease's potential risk and protective factors. Unfortunately, accumulating evidence suggests that there are few adequate tools to assess this disease among Hispanics.

Autobiographical memory is our memory for specific events and knowledge about our lives. It is composed of two subsystems, episodic memory, which is our memory for unique life events, and semantic memory, which is personal and general knowledge (Conway, 2005; Prebble et al., 2013). When these two systems work together, we can retrieve a specific, personal memory with meaning. As a whole, autobiographical memory defines who we have been, who we are, and it allows us to imagine who we will be (Schacter & Addis, 2007). Autobiographical memory is believed to be sensitive to normal cognitive aging and AD, as well as a variety of risk factors for AD. There are many other variables that can modify autobiographical memory, such as emotion, and personal relevance (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; St. Jacques & Levine, 2007). However, studies within the episodic autobiographical memory literature have been conducted with majority non-Hispanic White populations, or in populations in which race/ethnicity is not reported. Thus, virtually nothing is known about episodic autobiographical memory in Hispanics.

The overarching hypothesis of this project is that episodic autobiographical memory may be a culturally appropriate, and thus valid, cognitive measure of age-related cognitive decline and AD risk for Hispanics. This hypothesis is based on a theory that autobiographical memory draws on real-world, "personalized" events as opposed to more artificial and potentially culturally loaded learning contexts (e.g., word lists; studying and recalling in a traditionally White learning context). Given that a majority of Hispanics living in the US are bilingual, examining how episodic autobiographical memory and bilingualism are related is important. Therefore, the goal of the proposed research is to investigate, for the first time, episodic autobiographical memory in a U.S. sample of bilingual and monolingual Hispanics while examining related factors that might influence memory performance. To achieve this goal, this dissertation was designed to ask the following questions: 1) is episodic autobiographical memory sensitive to age in U.S. Hispanics?, 2) is bilingualism associated with episodic autobiographical memory in Hispanics?, and 3) is episodic autobiographical memory in Hispanics modulated by language at encoding/retrieval or related to inhibition? By addressing these questions, I hope to introduce episodic autobiographical memory testing as a novel neuropsychological approach through which to accurately capture age-related memory decline in U.S. Hispanics, which can set the stage for further work on characterizing the cognitive profile of AD risk in this population.

2. Background

There are approximately 5 million individuals diagnosed with AD in the United States (U.S.) (Hebert et al., 2013). Hispanics in the U.S. are not only overrepresented in this group, but they also are expected to experience the greatest increase in AD in the next four decades (Matthews et al., 2018). Unfortunately, accumulating evidence suggests that currently available cognitive tests may be less accurate at detecting cognitive decline in Hispanics (Puente et al., 2015; Hebert et al., 2013). As such, there is a critical need for better cognitive tests for age- and AD related cognitive decline in Hispanics.

Episodic autobiographical memory, which is our memory for personally relevant events, becomes less specific with older age such that older adults, relative to young adults, tend to generate less episodic detail (e.g. unique details about the event) to describe their event memories, while maintaining normal or elevated use of semantic and other language-based detail (Levine et al., 2002; Schacter, Gaesser, & Addis, 2013). More recently, it was revealed that reduced EAM specificity may be more sensitive than other memory tests to increased AD risk, as measured by the e4 allele of the apolipoprotein E gene, among cognitively normal older adults (Grilli, Wank, Bercel, & Ryan, 2018; Acevedo-Molina et al., 2022). This is consistent with a larger literature showing that EAM taxes a core memory network that is gradually affected by AD neuropathology (Gallagher et al., 2011; Murphy et al., 2008), and EAM gradually declines with progression from prodromal to clinical (dementia) staging of AD (Addis et al., 2009; Backman et al., 2001). There also is evidence that reduced EAM fluency and overall detail is correlated with elevated levels of amyloid biomarkers at clinical stages of AD (Tomadesso et al., 2019; Buckley et al., 2014). Prior findings, therefore, indicate that EAM specificity has the potential to be a sensitive measure of both normal and AD-risk related cognitive aging.

However, most of our knowledge of how EAM is affected in older adults comes from studies with samples that are primarily composed of non-Hispanic Whites, or with populations in which

cultural/ethnic background was not reported. Consequently, we know very little about EAM in Hispanics. The overarching goal of this project is to determine whether EAM testing holds promise as a new, culturally appropriate neuropsychological approach for age-related cognitive decline in Hispanics. This as an important step for revealing whether episodic autobiographical memory can be a new neuropsychological approach for the detection of both age and AD-related cognitive decline in Hispanics.

2.1. Aging and Episodic Autobiographical Memory in Hispanics

Despite decades of research on episodic autobiographical memory, to date, no study has directly focused on this type of memory in young or older U.S. Hispanics. One study, however, has examined episodic autobiographical memory in a non-U.S. sample of Colombians. This study examined episodic autobiographical memory in young and older monolingual Spanish-speakers in that country (De Brigard, Rodriguez, & Montañes, 2017). Using an adapted version of the well-established Autobiographical Interview, they found that older adults produced less episodic detail than young adults while remembering past events, suggesting that some Hispanic groups may show age-related decline in episodic specificity. Of note, the mean age of the young adults in this study was 19.10 years and the mean age of the older sample was 67 years.

Although studies of U.S. Hispanics have not examined episodic autobiographical memory, there has been considerable research on standard neuropsychological measures. In a recent, large-scale longitudinal study, performance on episodic learning and memory (e.g., list learning) was assessed in a sample of 13,017 ethnically diverse older adults followed every 3-4 years beginning at the age of 55. They found that individuals whose memory function declined over the course of the study were more likely to have a non-White ethnic background, to be less educated, to have a higher frequency of the ε4 allele of the APOE gene, which is a risk factor for AD, and were five times more likely to develop

dementia. The steepest decline in episodic memory was observed in Caribbean Hispanics compared to non-Hispanic Whites (Lee et al., 2018).

A variety of factors complicate the interpretation of Hispanic versus non-Hispanic White performances on standard neuropsychological tests. For instance, the increased diagnosis of dementia in older Hispanics may reflect an overestimation of decline, because the norms are not appropriate (Gerber, 1999). Equally problematic, neuropsychological tests may lack sensitivity to AD-related neuropathology in Hispanics. In a recent study in which Hispanics and non-Hispanic Whites with similar autopsy confirmed AD pathology were compared to cultural-matched controls, cognition was less severely impaired in the Hispanic AD group, according to standard neuropsychological tests (Weissberger et al., 2019). In light of these findings, it has been suggested that we may need more culturally appropriate tests for Hispanics, as so-called “hallmark” cognitive signs of aging and AD may be harder to capture in this group.

Notably, episodic autobiographical memory could fill the need for more culturally appropriate, individuated learning and memory neuropsychological testing, given that individuals are asked to describe personal events, which inherently come from their own cultural framework and background knowledge. However, it remains unknown whether EAM is as sensitive to increased age in Hispanics as it is in non-Hispanic Whites. It is important to close this gap in knowledge if we are to understand whether EAM testing represents a new approach for assessing normal and abnormal cognitive decline among older Hispanics.

2.2. Bilingualism and Episodic Autobiographical Memory

Although Hispanics, similar to non-Hispanic Whites, may tend to retrieve episodically rich memories, we also must acknowledge that there may be cultural differences in episodic autobiographical memory specificity. For instance, Wang and colleagues (Wang et al., 2011) examined

episodic specificity differences between young East Asians and European Americans. Using the standard Autobiographical Interview protocol (Levine et al., 2002) the authors found that relative to East Asians, European Americans produced more episodic details during memory retrieval. These findings provide evidence for the presence of cultural differences in episodic specificity in remembering. Whether there also are cultural differences between Hispanics and non-Hispanic Whites is unclear. It is important to characterize these cultural differences, not only for contextualizing the nature of episodic autobiographical memory in Hispanics but also for revealing factors that might influence performance, should episodic autobiographical memory become part of standard testing.

If there are cultural differences, Hispanics may in fact be a group that is more episodically specific when directed to describe episodic autobiographical memories in as much detail as possible. An important feature about the population of Hispanics in the U.S. is they are commonly bilingual, which is thought to confer certain cognitive benefits. Some of these cognitive benefits are relevant to EAM. For instance, bilingualism is linked to better executive functions in some lines of research (Paap & Sawi, 2014; Bialystok, Craik, & Luk, 2012). Executive functions, in turn, have been associated with higher episodic specificity (Addis, Wong, & Schacter, 2008; Piolino et al., 2008). From this viewpoint, bilingual Hispanics might tend to describe EAMs in more episodic detail than both monolingual Hispanics and monolingual non-Hispanic Whites. However, whether potential cultural differences could be explained entirely by bilingualism remains an empirical question.

Additionally, it is interesting to consider whether bilingualism may alter the relationship between age and episodic specificity. Notably, bilingualism has been extensively examined in the context of AD. One main question of interest has been understanding whether bilingualism is protective against age and AD-related cognitive decline. This work has generally suggested that bilingualism can at the very least delay AD cognitive symptoms, perhaps through higher “cognitive reserve,” which refers to the

influence of individual differences in intelligence and perhaps something akin to experience-based cognition on the susceptibility of an individual to show clinical signs of pathological brain changes (Stern, 2012).This is evidenced by studies showing that the number of languages an individual speaks is positively correlated with the age of symptom onset and diagnosis of AD (Bialystok et al., 2014; Kavé et al., 2008; Chertkow et al., 2010). From this standpoint, it may be the case that bilingual Hispanics show a weakened relationship between age and episodic specificity. This would be valuable information for standardizing episodic autobiographical memory testing in Hispanics. It also may signal that assessing memory in one language is more sensitive to age effects than another language, which is relevant to neuropsychology.

2.3. Language use, Inhibition, and Episodic Autobiographical Memory

From a cognitive psychology perspective, a noteworthy feature of bilingualism is that it raises the opportunity for language-related encoding and retrieval effects. For instance, according to the ideas of encoding specificity and transfer appropriate processing (Tulving & Thompson, 1973), EAM specificity may be higher when there is harmony between the language used at encoding and retrieval. Therefore, specificity in bilingual Hispanics may vary according to encoding/retrieval congruence, that is whether the language, and by extension frame of mind, used at encoding matches the language used at retrieval. Also, whether there are meaningful differences with monolinguals may depend on this feature. Notably, while prior studies have examined encoding/retrieval effects, they have focused on age of memories (e.g., memories from before or after immigration (Marian & Neisser, 2000). They have not, however, directly addressed the issues of language overlap at encoding and retrieval.

Moreover, as noted, the ability to speak more than one language also has been associated with enhanced executive functioning, in particular inhibition and cognitive switching (Bialystok et al., 2014; Tao, Taft, & Gollan., 2015), as well as delaying the clinical effects of brain damage caused by injury or

diseases such as AD. Interestingly, these effects seem to be amplified in older bilinguals, suggesting that lifelong bilingualism may be beneficial in aging (Bialystok et al., 2014; Gold et al., 2013). Yet, there is controversy in this area, as other studies examining executive functions in bilinguals have not found an advantage (Kousaie & Phillips, 2012; Paap & Grennberg, 2013). That said, a recent meta-analysis found that a bilingual advantage in inhibitory control exists (most commonly tested with the Stroop test) for older adult bilinguals compared with monolinguals (Armstrong et al., 2019). Critically, speaking to the robustness of the effect, individual characteristics, such as age of acquisition and frequency of use of a second language, did not modulate the bilingual advantage. In light of the connection between bilingualism and inhibition, it is noteworthy that, as mentioned, higher episodic specificity has also been associated with better inhibition (Schroeder & Marian, 2012). The present study will therefore explore the connection between inhibition and EAM in Hispanics, which remains unknown.

2.4. Objectives of the Present Study

The overarching goals of the present study were to contribute to our knowledge of episodic autobiographical memory in Hispanics and determine whether bilingualism has an influence on episodic specificity in this group. The three aims, along with their hypotheses, were as follows:

- **Aim 1. To determine if episodic autobiographical memory specificity is sensitive to age in cognitively normal Hispanics.**
    - **H_1.** Older Hispanics will show an age-related reduction in episodic autobiographical memory specificity relative to young Hispanics. **H_2** Similar to non-Hispanic Whites, this age-related reduction in episodic autobiographical memory will be driven by a reduction in episodic detail accompanied by stable or increased external/semantic detail.
- **Aim 2. To reveal whether bilingualism influences episodic autobiographical memory specificity.**

- **H_1.** Bilingual Hispanics will demonstrate higher episodic autobiographical memory specificity, as measured by episodic detail generation, relative to monolingual Hispanics, and monolingual non-Hispanic Whites.

- **Aim 3. To explore the influence of language use and inhibition on episodic autobiographical memory specificity.**
  - **H_1.** Memories generated using the same language used when the event happened (e.g., match) will be more episodically specific than memories retrieved using a different language than the one used when the event occurred (e.g., mismatch). **H_2.** In addition to the link between bilingualism and inhibition, inhibition is also thought to contribute to episodic autobiographical memory specificity as it has been associated with retrieving specific events (Schroeder & Marian, 2012). Thus, better performance in an inhibition task will be correlated with greater episodic autobiographical memory specificity in Hispanics.

3. Methods

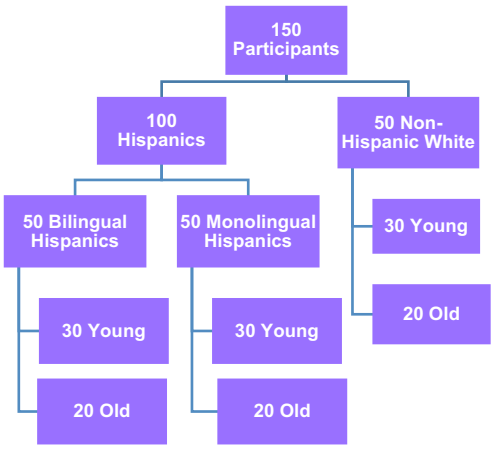
3.1. Participants

Figure 1 summarizes the number of participants in each group. One-hundred and fifty young and middle-aged/older adults participated in this study (50 bilingual Hispanics; 50 monolingual English-speaking Hispanics; and 50 monolingual English-speaking non-Hispanic Whites). Those classified as young adults were between the ages of 18-35 and middle-aged/older adults were older than 50. Informed consent was provided by all participants and all study procedures were in compliance with the Institutional Review Board at the University of Arizona.

Diverse representation in sample

Following the Psychology Department's commitment to diversity, equity, and inclusion, more than 50 percent of the sample included in this study is Hispanic, a population considered underrepresented in psychological research.

Figure 1. Participants



3.2. Study Procedures

This dissertation combines data from two study protocols, both of which were largely run in a remote/virtual environment during the first 1.5 years of the COVID-19 Pandemic. The first study protocol was focused on Hispanic individuals. In this study, potential participants were phone screened to determine study eligibility, which included being Hispanic per self-report, being proficient in English, and denying a history of psychiatric illness, head trauma, or neurological disorder. We screened for bilingualism via phone using the Language Experience and Proficiency Questionnaire (LEAP-Q) (Marian, Blumfield, & Kaushanskaya, 2007). In line with previous studies, only participants who rated themselves at least 7 on a 1–10 scale in speaking, understanding, and reading in both English and Spanish were placed in the bilingual group. Hispanic individuals who reported knowing English only or who rated themselves 6 or lower on the LEAP-Q for Spanish were considered English monolingual. During the initial phone screen, we also administered the Telephone Interview for Cognitive Status (TICS). Participants had to score 26 or higher on the TICS to be included in the study (Manly et al., 2011). This cutoff was selected based on work by Manly and colleagues, which showed that this cutoff maximized sensitivity and specificity between normal cognition and mild cognitive impairment in Hispanics and non-Hispanic White older adults (Manly et al., 2011). The consent process was done using REDCap econsent. Following enrollment, participants received instructions for their video conference appointment, along with instructions on how to access the online Stroop, which was administered during our video conference. Bilingual participants were also asked to complete the rest of the LEAP-Q (we asked question #3 as part of the screen). On testing day, all participants completed the Autobiographical Interview and the online Stroop task. Older adults also received the California Verbal Learning Test (CVLT-II). Participants received monetary compensation.

The non-Hispanic White group participated in a separate study of aging and memory that was done virtually. They completed the Autobiographical Interview among other tasks. These individuals were screened using the same psychiatric/neurologic exclusionary criteria and they were selected based on being close matches in age, gender, and education to the participants in the first study. Finally, to be included in the present analyses, they needed to report being monolingual English. Although the older adult participants received the CVLT-II, they did not complete the online Stroop task**.**

3.3. Measures

3.3.1. *Language Experiences and Proficiency Questionnaire (LEAP-Q:* Marian, Blumfield, & Kaushanskaya, 2007*)*: The Language Experience and Proficiency Questionnaire is a validated questionnaire tool for collecting self-reported proficiency and experience data from bilingual speakers ages 14 to 80. It is available in over 20 languages, and can be administered in a digital, paper-and-pencil, and oral interview format. The LEAP-Q is used to provide a comprehensive description of their bilingual participants and to screen participants for adequate or threshold levels of language proficiency.

3.3.2. *Autobiographical Interview (Levine et al., 2002)*: The Autobiographical Interview (Levine et al., 2002) is a well-established method for assessing autobiographical memory. Participants are asked to retrieve unique event memories (i.e., episodic autobiographical memories) from different time periods and describe them in detail. For monolinguals, a total of 5 memories were retrieved. For bilinguals, 10 memories were retrieved, one in English and one in Spanish for each of the 5 time periods (order of Spanish and English was counterbalanced across bilinguals). Consistent with prior research (Levine et al., 2002; Grilli et al., 2018), participants were given 5 minutes to describe each memory, and they were given one general prompt (i.e., can you tell me more?). The narratives were audio recorded and later transcribed. Transcribed narratives

were separated into individual details, and each detail was scored as internal (e.g. description of the event, sensory details specific to the event) or external (e.g. semantic or factual statements, or other details not specific to the event) using an established two-rater system for reliability (Verfaellie et al., 2014). Because the language in which instructions are provided may influence memory, for the bilingual group, the instructions for each condition were provided in the language with which the memory would be narrated in (e.g. instructions provided in Spanish for memories that will be narrated in Spanish).

Immediately after narrating each memory, participants rated the event on a 6-point scale for the following: how clearly they could visualize the event (1=*not very clear*, 6=*very clear*), how emotional was the event (1=*no at all emotional*, 6=*very emotional*), how personally relevant was the event *then* (1=*not personally relevant*, 6=*very personally relevant*), and how personally relevant is the event *now* (1=*not personally relevant*, 6=*very personally relevant).* The Non-Hispanic White cohort did not rate their memories on the above-mentioned characteristics, instead they rated them on other characteristics relevant to the broader scope of the separate study of aging and memory that was done virtually. Please see the Supplemental Materials sections for ratings of phenomenological characteristics of memories narrated by Hispanics.

3.3.3. *Telephone Interview for Cognitive Status (TICS: Brandt and Folstein, 1988):* The TICS is a brief, 11-item test of cognitive functioning with scores ranging from 0 to 41. Questions of orientation, repetition, naming, and calculations are some of the items covered. Additionally, a 10-item (i.e., 10 words) non-semantically related word list is recalled immediately. The individual item scores are summed to obtain the TICS Total score. The TICS Total score provides a measure of global cognitive functioning and can be used to monitor changes in cognitive functioning over time.

3.3.4. *California Verbal Learning Test, Second Edition (CVLT-II: Delis, Kramer, Kaplan, and Ober, 2001):* The California Verbal Learning Test measures episodic verbal learning and memory. The experimenter reads a list of 16 nouns aloud, over five learning trials (list A). After each trial, the subject is asked to recall as many words as they can in any order (i.e., free recall). The words from the list are drawn from four semantic categories. After an interference list (list B) is presented, free and cued recall of list A are tested immediately (short-delay), and again after 20 minutes (long-delay). In cued recall, the experimenter prompts the subjects with the semantic word category. The test ends with a recognition task, where the experimenter presents the subject with a word list, and the subject must indicate whether it is a target word or a distractor.

3.3.5. *Online Stroop:* An online version of the Stroop Test was created using JavaScript. This online version was modeled after the Color-Word Interference Test from the Delis-Kaplan Executive Function System (DKEFS: Delis, Kaplan, Kramer, 2001). However, our online version only included the first three conditions (i.e., color naming, word reading, and inhibition). For the color naming condition, participants were presented with a red, green, or blue-colored circle, and were instructed to identify the color of the circle by pressing a particular key (e.g., pressing 'B' for blue, 'G' for green, or 'R' for red). Similarly, for the word reading condition, they were presented with a color word and instructed to identify the word by pressing a key. Lastly, for the inhibition condition, they were shown a color word printed in different-colored ink and instructed to identify the color of the ink the letters were printed in and not the read the word. All conditions began with practice trials and each condition had five trials of ten items, like the DKEFS conditions. Reaction times were recorded for each trial.

3.4. COVID-19 Pandemic Mitigation

Twelve young bilingual Hispanics completed the study in person prior to halting in-person research at the start of the COVID-19 pandemic. The rest of the participants completed the study over Zoom for Health.

3.5. Detail Scoring and Reliability

We used the Autobiographical Interview scoring protocol developed by Levine and colleagues (St. Jacques & Levine, 2007). In this protocol, trained raters break each narrative down into detail segments, and then score these segments as either "internal" or "external" to the main event being described. Internal details are typically characterized as episodic details, including event, time, place, perceptual, and thought/emotion details. External details include semantic details, along with repetitions, meta or editorial comments, and descriptions of external events. Memories generated by bilingual and monolingual Hispanics were scored by two scorers who were trained on the Autobiographical Interview materials. Each person scored half of the narratives. Inter-rater reliability for detail scoring was calculated based on a random selection of ten young adults and ten older adults (approximately 20% of the total number of Hispanic participants), which were scored by all raters. Inter-rater reliability for total details, episodic details, semantic details, and other details was good to excellent (Cronbach's α's range = .83 to .93). Memories generated by monolingual non-Hispanic White participants were scored by trained raters as well. These raters also achieved good to excellent reliability (Cronbach's α's > .80). See Supplemental Materials section for examples of memories generated by participants.

3.6. Statistical Analyses

Demographics

Table 1 shows demographic and neuropsychological data for all groups. We ran a series of independent samples t-tests to compare young and older adults on the variables presented in Table 1.

See Table 2 for sample characteristics for the bilingual Hispanics obtained via self-report using the LEAP-Q.

Aims 1 and 2

To determine if episodic autobiographical memory specificity is sensitive to age in cognitively normal Hispanics, and to reveal whether bilingualism influences episodic autobiographical memory specificity we ran a 3(Group: Bilingual Hispanics vs Monolingual Hispanics vs Non-Hispanic Whites) x 2(Detail type: Internal vs. External) x 2(Age: Young vs. Middle-aged/Older) repeated measures ANOVA. Significant main effects and interactions were followed up with relevant post-hoc tests. We used Holm correction p-values to avoid family wise error.

Given that there were group differences in total details generated, we also examined the effects of group and age on episodic specificity scores (e.g., internal details: total details). These analyses allow us to better understand how the episodic quality of these memories differed between groups, after correcting for total details provided. All analyses for Aims 1 and 2 were done using the memories retrieved in English by the bilingual Hispanics and were repeated using the memories retrieved in Spanish by this group.

Sample used: 50 bilingual Hispanics, 50 monolingual Hispanics, 50 non-Hispanic Whites

Aim 3

Part 1: To better understand whether the congruence between language use at encoding and retrieval influences episodic autobiographical memory specificity in bilinguals, we calculated match (i.e., language at encoding same as language at retrieval) and mismatch (i.e., language at encoding different than language at retrieval) trials using participants' answers to a post-retrieval question (i.e., was the language that you used to retrieve the memory the same as the language in which it was

encoded?). Then, we conducted a paired-samples t-test between mean episodic detail of matched vs. mismatched trials.

Sample used: 50 bilingual Hispanics

Part 2: To explore whether the link between bilingualism and inhibition is relevant to episodic autobiographical memory specificity, we used a hierarchical multiple regression, with scores from the inhibition trial of the online Stroop Test being the dependent variable. Episodic specificity scores and bilingualism status (bilingual versus monolingual), were added as independent/predictor variables, in a step after age. Age was entered first given the established relationship between older age and lower inhibition. The interaction between age and bilingualism status was added as a predictor in the third step. As reported below, there was a significant interaction between age and bilingualism. We therefore followed this analysis by running separate regressions for each age group.

Sample used: 50 bilingual Hispanics, 50 monolingual Hispanics

Autobiographical Memory Ratings

Supplemental table 1 summarizes mean phenomenological ratings from the Autobiographical Interview reported by Hispanics. We ran a series of independent samples t-tests to examine group differences.

4. Results

Table 1. Sample characteristics by age group

	Young Adults				Middle-aged/Older Adults			
Group	**Bilingual Hispanics**	**Monolingual English-speaking Hispanics**	**Non-Hispanic Whites**	***p***	**Bilingual Hispanics**	**Monolingual English-speaking Hispanics**	**Non-Hispanic Whites**	***p***
Age *M*(SD)	25.6 (4.55) Range: 19-35	24.6 (3.07) Range: 18-32	24.2 (4.02) Range: 19-35	.36	64.4(5.58) Range: 50-72	65.2(4.30) Range: 62-78	67(5.25) Range: 54-75	.24
Education *M*(SD)	17.4 (2.18)	16.7 (3.09)	16.86 (2.31)	.54	18.6(1.34)	17.1 (2.03)	17.8(1.05)	.07
Gender, male (%)	12 (40%)	13 (43%)	12 (40%)	-	9(45%)	8(40%)	9(45%)	-
TICS score *M*(SD)	30.3 (1.7)	30.5 (1.3)	-	.61	29.7(1.2)	30(1.4)	-	.47
CVLT-2 Long Delay Free Recall Raw Scores	-	-	-	-	11.2(2.01)	11.4(1.02)	11.7 (1.05)	.54

Table 2. Bilingual sample characteristics by age group reported on the LEAP-Q

	Young adults (N=30)		**Middle-aged/Older Adults** (N=20)	
	English	**Spanish**	**English**	**Spanish**
Dominant language, *n*	16	14	15	5
First language acquired, *n*	8	22	0	20
Age of acquisition, *M*(SD)	5.6 (2.9)	1.7 (1.6)	5.0(3.60)	0.4 (0.54)
Proficiency				
Speaking, *M*(SD)	8.5 (1.0)	9.4 (.95)	9.2(0.83)	7.4(0.54)
Understanding the spoken language, *M*(SD)	8.9 (.97)	9.7 (.67)	9.6(0.54)	8.4(1.14)
Reading, *M*(SD)	8.9 (0.9)	9.2 (1.1)	9.6(0.55)	8.2(0.83)

4.1. Aims 1 and 2: Is episodic autobiographical memory sensitive to age in cognitively normal Hispanics and does bilingualism influence the specificity of episodic autobiographical memory?

4.1.1. Analyses using bilingual Hispanics' memories in English

Figure 2 shows internal and external details generated by all groups. A 3(Group: Bilingual Hispanics vs Monolingual Hispanics vs Non-Hispanic Whites) x 2(Age: Young vs Middle-aged/older) x 2(Detail Type: Internal vs External) repeated measures ANOVA revealed a main effect of detail type, *F*

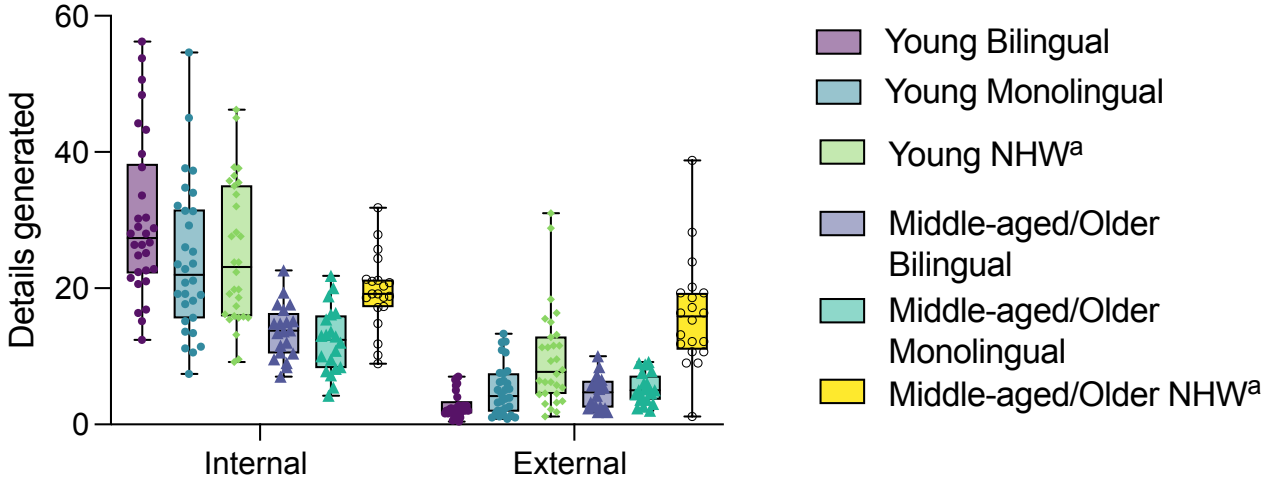
(1, 144) = 312.40, p <.001, $\eta_p^2 = .35$, such that all groups generated more internal than external details, t = 17.68, p <.001, d = 1.44. There was also a main effect of age, F (1, 144) = 19.79, p <.001, $\eta_p^2 = .03$, such that young adults' memories were more detailed than middle-aged/older adults' memories, t = 4.49, p <.001, d = .36. Additionally, there was a main effect of group, F (2, 144) = 14.67, p <.001, $\eta_p^2 = .05$, such that bilingual and monolingual Hispanics' memories were less detailed than the memories of the non-Hispanic Whites, t's = 4.83, p's <.001, d's >.33. Bilingual and monolingual Hispanics' memories did not differ on the amount of overall detail generated, t = .92, p = .35, d =.07.

Main effects were qualified by several significant interactions. There was a significant interaction between detail type and group, F (2, 144) = 469.76, p <.001, $\eta_p^2 = .03$. Bilingual Hispanics generated more internal details than monolingual Hispanics, t = 2.44, p = .04, but not non-Hispanic Whites, t = 0.28, p = .77. Non-Hispanic Whites generated more internal details than monolingual Hispanics, t = 2.73 p = .02. Regarding external details, non-Hispanic Whites generated more external details than bilingual and monolingual Hispanics, t's > 5.19, p's <.001. Bilingual and monolingual Hispanics did not differ on the number of external details generated, t = 0.99, p = .63. There were also significant differences regarding the ratio of internal vs external details generated by the groups. That is, bilingual Hispanics, monolingual Hispanics, and non-Hispanic Whites, generated more internal details than they did external, t's > 7.05, p's <.001. The number of internal details generated by the bilingual Hispanics was higher that the number of external details generated by monolingual Hispanics and non-Hispanic Whites, t's > 5.96, p's <.001. The number of internal details generated by the Monolingual Hispanics was also higher than the number of external details generated by bilingual Hispanics, and non-Hispanic Whites, t's > 3.51, p's <.03. The number of internal details generated by the non-Hispanic Whites was also higher than the number of external details generated by the bilingual and monolingual Hispanics, t's = 11.44, p's <.001.

There was also a significant interaction between detail type and age, F (1, 144) = 87.02, p <.001, $\eta_p^2 = .09$, such that middle-aged/older adults generated less internal, but more external details than young adults, t's > 2.38, p's <.02. Regarding the ratio of internal vs external detail, young and middle-aged/older adults generated more internal details than they did external, t's > 5.38, p's <.001. The number of internal details generated by the older adults was also higher than the number of external details generated by the young adults, t = 7.60, p <.001.

Lastly, there was a significant interaction between group and age, F (2, 144) = 6.38, p = .002, $\eta_p^2 = .02$, such that middle-aged/older bilingual Hispanics' memories were less detailed than the memories of the young bilingual Hispanics, young monolingual Hispanics, and the young and middle-aged older non-Hispanic Whites, t's > 3.34, p's <.008. Middle-aged/older bilingual Hispanics and monolingual Hispanics did not differ on the amount of overall detail generated, t = 0.17, p = 1.00. Middle-aged/older monolingual Hispanics' memories were also less detailed than the memories of the young bilingual Hispanics, young monolingual Hispanics, and young and middle-aged/older non-Hispanic Whites, t's > 3.54, p's <.005. Middle-aged/older non-Hispanic Whites' overall detail generation did not differ from the young non-Hispanic Whites, bilingual Hispanics, and monolingual Hispanics, t's < .29, p's >.35. There was no significant three-way interaction between group, detail type, and age, F (2, 144) 2.01, p =.13, $\eta_p^2 = .00$.

Figure 2. Internal and External Details Generated by Group



Notes: [a]NHW = Non-Hispanic White; Data shown for the bilingual group is from memories retrieved in English.

Figure 2. Boxplot of internal and external details generated by each group. The box captures the upper and lower quartiles, and the median is represented by a solid line within the box for each group.

4.1.2. Follow-up analyses using specificity scores

An ANOVA with specificity scores as the dependent variable, with factors of age (i.e., young vs middle-aged older) and group (i.e., bilingual Hispanic vs monolingual Hispanic vs non-Hispanic Whites), revealed a main effect of group, F (2, 144) = 26.04, p <.001, $\eta_p^2 = .19$, such that bilingual Hispanics' memories had a higher proportion of internal detail relative to monolingual Hispanics and non-Hispanic Whites, t's > 2.68, p's <.02, d's >.45. Further, relative to non-Hispanic Whites, monolingual Hispanics' memories had a higher proportion of internal details, t = 4.46, p <.001, d =.73. Additionally, there was a main effect of age, F (1, 144) = 74.74, p <.001, $\eta_p^2 = .27$, such that young adults' memories had a higher proportion of internal details relative to those of middle-aged/older adults, t = 8.64, p <.001, d =1.23. Lastly, there was not a significant interaction between group and age, F (2, 144) = 0.71, p = .49, $\eta_p^2 = .00$.

Figure 3. Specificity Scores by Age Group

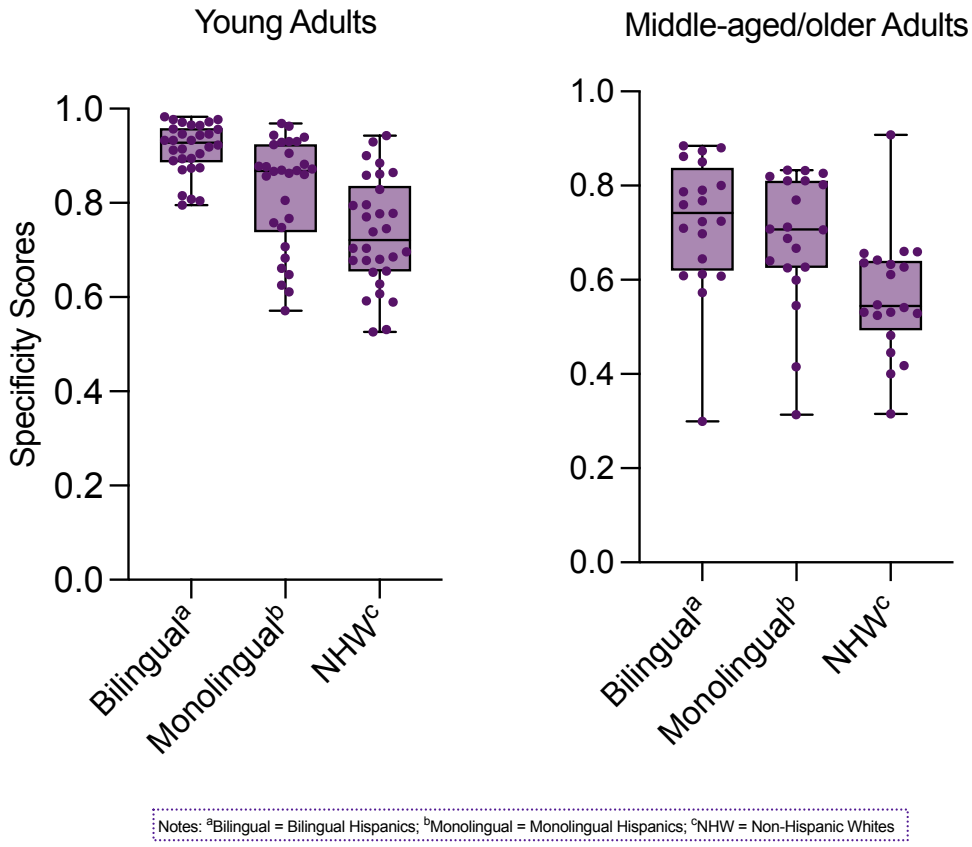


Figure 3. Boxplot of specificity scores generated by age group. Data shown for the bilingual groups is for memories retrieved in English. The box captures the upper and lower quartiles, and the median is represented by a solid line within the box for each group.

4.1.3. Analyses using bilingual Hispanics' memories in Spanish

Figure 4 shows internal and external details generated by all groups. A 3(Group: Bilingual Hispanics vs Monolingual Hispanics vs Non-Hispanic Whites) x 2(Age: Young vs Middle-aged/older) x 2(Detail Type: Internal vs External) repeated measures ANOVA revealed a main effect of detail type, F (1, 144) = 266.71, p <.001, $\eta_p^2 = .64$, such that all groups generated more internal than external details, t = 16.30, p <.001, d = 1.31. There was also a main effect of age, F (1, 144) = 20.99, p <.001, $\eta_p^2 = .12$, such that young adults' memories were more detailed than middle-aged/older adults' memories, t = 4.58, p <.001, d = .37. Additionally, there was main effect of group, F (2, 144) = 13.93, p <.001, $\eta_p^2 =$

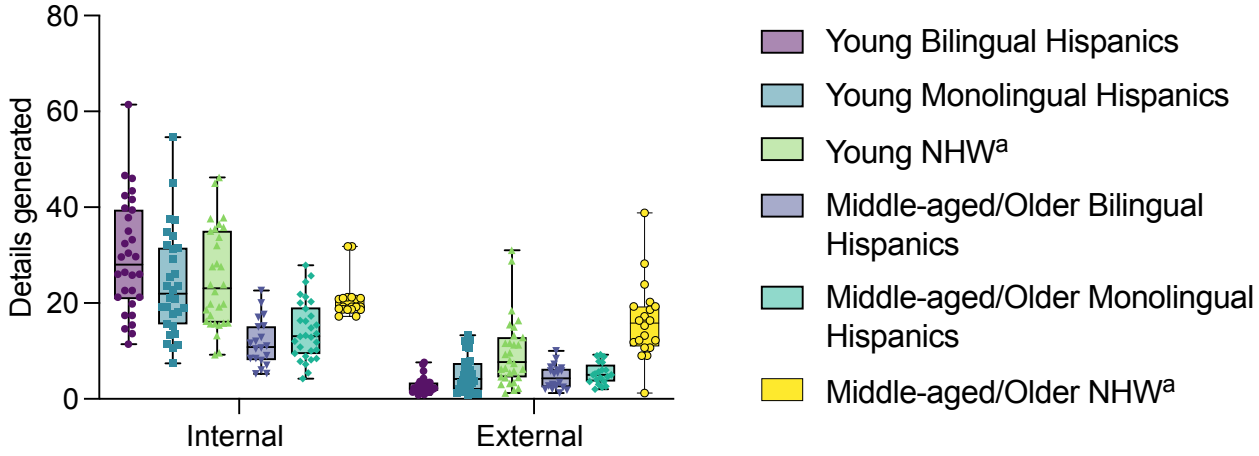
.16, such that bilingual and monolingual Hispanics' memories were less detailed than the memories of the non-Hispanic Whites, *t*'s > 4.28, *p*'s <.001, *d*'s >.35. Bilingual and monolingual Hispanics' memories did not differ on the number of overall details generated, *t* = .53, *p* = .59, *d* =.04.

Main effects were qualified by the following significant interactions. There was a significant interaction between detail type and group, *F* (2, 144) = 8.21, *p* <.001, $\eta_p^2 = .02$. The number of internal details generated by the bilingual Hispanics did not differ from the number of internal details generated by monolingual Hispanics and non-Hispanic Whites, *t*'s < 1.79, *p*'s > .22. Monolingual Hispanics generated less internal details than the non-Hispanic Whites, *t* = 2.73, *p* = .02. Similar to analyses using memories in English for the bilingual Hispanics, there were also significant differences regarding the ratio of internal vs external details generated by the groups. Bilingual Hispanics, monolingual Hispanics, and non-Hispanic Whites generated more internal details than they did external, *t*'s > 6.63 *p*'s <.001. The number of internal details generated by the bilingual Hispanics was higher than the number of external details generated by monolingual Hispanics and non-Hispanic Whites, *t*'s > 5.11, *p*'s <.001. The number of internal details generated by the Monolingual Hispanics was also higher than the number of external details generated by bilingual Hispanics, and non-Hispanic Whites, *t*'s > 3.32, *p*'s <.002. The number of internal details generated by the non-Hispanic Whites was also higher than the number of external details generated by the bilingual and monolingual Hispanics, *t*'s > 10.80, *p*'s <.001.

There was also a significant interaction between detail type and age, *F* (1, 144) = 83.99, *p* <.001, $\eta_p^2 = .36$, such that middle-aged/older adults generated less internal, but more external details than young adults, *t*'s > 2.20, *p*'s <.02. Regarding the ratio of internal vs external detail, young and middle-aged/older adults generated more internal details than they did external, *t*'s > 4.60, *p*'s <.001. The number of internal details generated by the older adults was also higher than the number of external details generated by the young adults, *t* = 6.69, *p* <.001.

Lastly, there was a significant interaction between group and age, F (2, 144) = 7.00, p = .001, η_p^2 = .08, such that middle-aged/older bilingual Hispanics' memories were less detailed than the memories of the young bilingual Hispanics, young monolingual Hispanics, and the young and middle-aged older non-Hispanic Whites, t's > 4.86, p's <.002. Middle-aged/older bilingual Hispanics and monolingual Hispanics did not differ in the numbers of overall details generated, t = 0.34, p = 1.00. Middle-aged/older monolingual Hispanics' memories were also less detailed than the memories of the young bilingual Hispanics and young and middle-aged/older non-Hispanic Whites, t's > 3.73, p's <.002. Middle-aged/older non-Hispanic Whites' overall detail generation did not differ from the young non-Hispanic Whites, bilingual, and monolingual Hispanics, t's < 1.77, p's >.44. There was not a significant three-way interaction between group, detail type, and age, F (2, 144) = 2.98, p = .053, η_p^2 = .007.

Figure 4. Internal and External Details Generated by Group



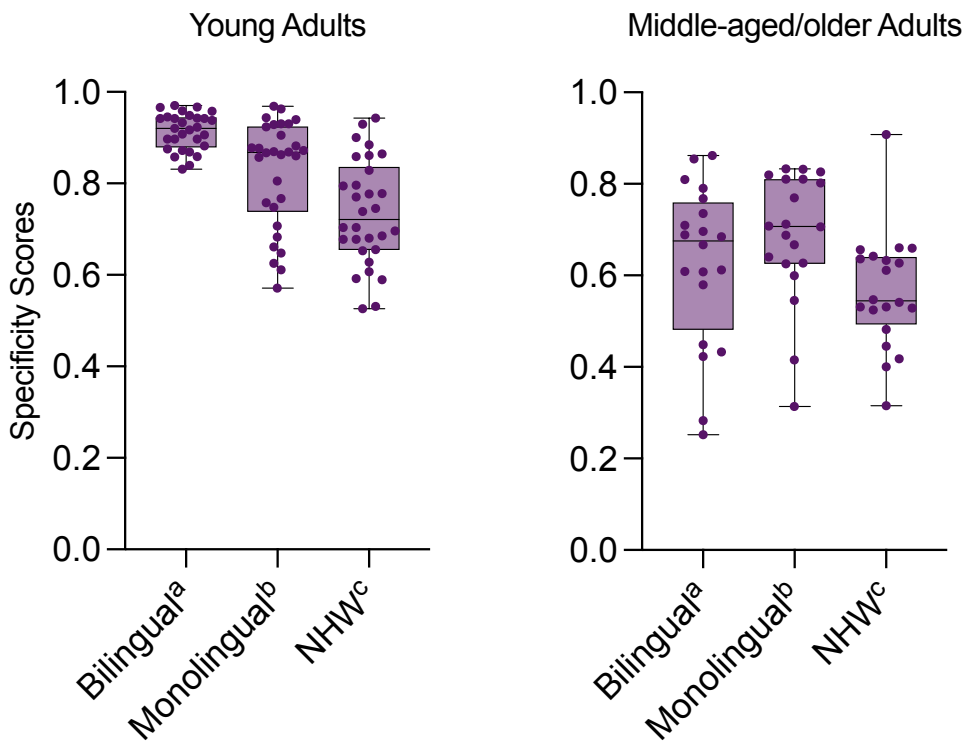
Notes: [a]NHW = Non-Hispanic White; Data shown for the bilingual group is from memories retrieved in Spanish.

Figure 4. Boxplot of internal and external details generated by each group. The box captures the upper and lower quartiles, and the median is represented by a solid line within the box for each group.

4.1.4. Follow-up analyses using specificity scores

An ANOVA with specificity scores as the dependent variable, with factors of age (i.e., young vs middle-aged older) and group (i.e., bilingual Hispanic vs monolingual Hispanic vs non-Hispanic Whites), revealed a main effect of group, F (2, 144) = 9.90, p <.001, $\eta_p^2 = .12$, such that bilingual Hispanics' memories had a higher proportion of internal detail relative non-Hispanic Whites, t = 3.89, p <.001, d =.60. Further, relative to monolingual Hispanics, non-Hispanic Whites' memories had a lower proportion of internal details, t = 4.46, p <.001, d =.73 Bilingual and monolingual Hispanics' memories did not differ on specificity, t = 0.07, p =0.99, d =.01. Additionally, there was a main effect of age, F (1, 144) = 71.61, p <.001, $\eta_p^2 = .33$, such that young adults' memories had a higher proportion of internal details relative to those of middle-aged/older adults, t = 8.46, p <.001, d =1.30. Lastly, there was a not significant interaction between group and age, F (2, 144) = 2.86, p = .06 $\eta_p^2 = .04$.

Figure 5. Specificity Scores by Age Group



Notes: [a]Bilingual = Bilingual Hispanics; [b]Monolingual = Monolingual Hispanics; [c]NHW = Non-Hispanic Whites

Figure 4. Boxplot of specificity scores generated by age group. Data shown for the bilingual groups is for memories retrieved in Spanish. The box captures the upper and lower quartiles, and the median is represented by a solid line within the box for each group.

4.2. Do language use and inhibition influence episodic specificity?

Part 1: A paired samples t-test between mean episodic details of match versus mismatched trials was not statistically significant, $t(49) = -0.58$, $p = 0.56$, $d = .08$, such that the relationship between language at encoding and language at retrieval did not influence episodic specificity.

Part 2: A hierarchical multiple regression was run to determine whether age, episodic specificity, bilingualism status, and the interaction between bilingualism status and age, predicted performance on the Stroop test. Age was added in the first step, while episodic specificity scores and bilingualism status were added in the second step. The interaction between age and bilingualism status was added in the third step. The full model of age, episodic specificity scores, bilingualism status, and the interaction between bilingualism status and age was statistically significant, $F(4, 98) = 173.79$, $p < .001$; adjusted $R^2 = .88$. Age was a significant predictor of inhibition performance ($\beta = .428$, $p < .001$). While bilingualism status ($\beta = .089$, $p = .070$), and episodic specificity scores ($\beta = -.028$, $p = .536$), were not significant predictors, the interaction between age and bilingualism status was a significant predictor ($\beta = .205$, $p < .001$).

To assess differences in inhibition performance, we ran separate regressions for each age group, with inhibition scores as the dependent variable and specificity and bilingualism status as predictors. Neither specificity ($\beta = .239$, $p = .09$) or bilingualism status ($\beta = .224$, $p = .11$) were significant predictors among the young adults. However, bilingualism status ($\beta = .674$, $p < .001$) was a significant predictor of inhibition performance among middle-aged/older adults. Specificity was not a significant predictor among middle-aged/older adults ($\beta = -.151$, $p = .22$). An independent-samples t-test revealed

that middle-aged/older bilingual Hispanics had higher reaction times (i.e., worse performance) than middle-aged/older monolingual Hispanics, t = -5.33, p <.001, d = 1.68.

Figure 6. Performance on the Stroop Versus Specificity Scores by Age Group

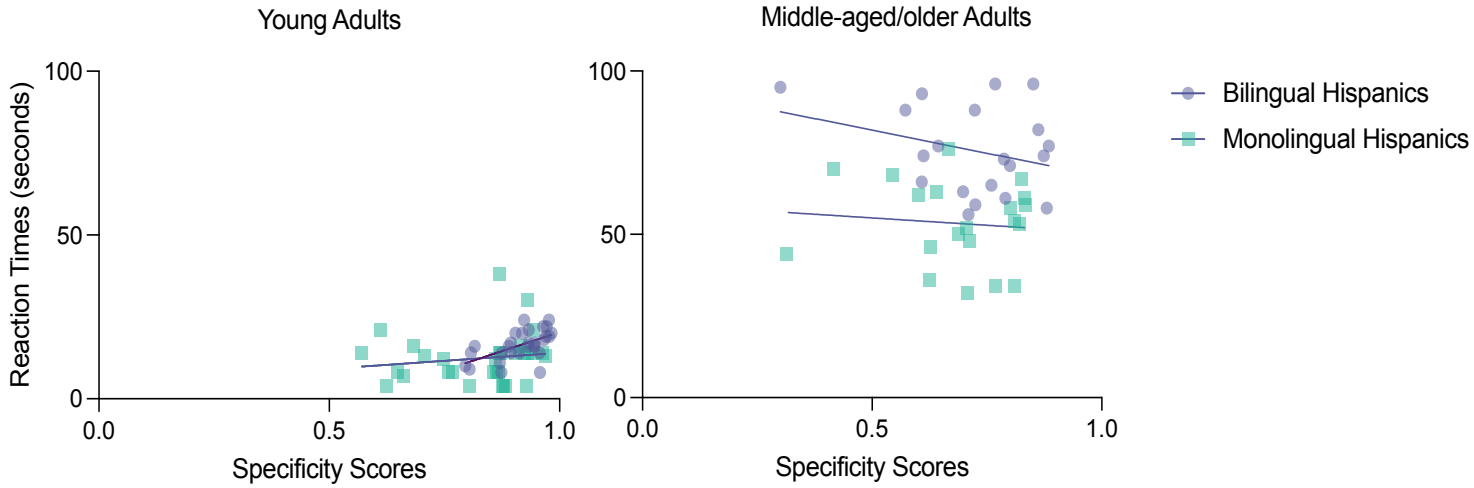


Figure 6. Relationship between performance on the Stroop task and specificity scores. Data is shown by bilingualism status (bilingual vs. monolingual) and age (young vs. middle-aged/older).

5. Discussion

Hispanics in the United States are expected to experience the greatest increase in AD diagnoses in the next four decades (Novak & Riggs, 2004; Hebert, Weuve, Scherr, & Evans, 2013; Matthews et al., 2018). Developing culturally sensitive neuropsychological tests could improve early detection and treatment of AD in this population. Studies with majority non-Hispanic White samples (or samples with unreported race/ethnic background) have shown that episodic autobiographical memory is sensitive to aging, risk for cognitive decline associated with AD, and AD dementia (Levine et al., 2002; Schacter, Gaesser, & Addis, 2013; Grilli, Wank, Bercel, & Ryan, 2018; Acevedo-Molina et al., 2022; Gallagher et al., 2011; Murphy et al., 2008). Intriguingly, episodic autobiographical memory may be a culturally appropriate measure for Hispanics, because it draws on real-world, "personalized" events as opposed to more artificial and potentially culturally loaded memory contexts. However, virtually nothing is known about episodic autobiographical memory in U.S. Hispanics. Given that the majority of Hispanics in the U.S. are bilingual, examining how episodic autobiographical memory and bilingualism are related is important as well. In the present study, we found that episodic autobiographical memory is sensitive to older age among a sample consisting primarily of cognitively normal U.S. Hispanics. Notably, we also found that bilingualism provides an advantage to episodic autobiographical memory. Lastly, we found that a match or mismatch between the language spoken at encoding and the language spoken at retrieval did not significantly influence episodic specificity. Additionally, we found that episodic specificity did not predict performance on an inhibition task and that middle-aged/older bilingual Hispanics had worse inhibition overall.

5.1. Is episodic autobiographical memory sensitive to age in Hispanics?

Our study is the first to examine and find that episodic autobiographical memory is sensitive to older age in cognitively normal Hispanics. That is, across the racially/ethnically diverse sample, we

found that episodic detail was lower among middle-aged older adults relative to young adults, whereas external detail was higher. Importantly, this age difference did not significantly differ in groups varying in race/ethnicity and/or bilingualism, nor did the results significantly change if we used Spanish memories in the bilingual individuals. Relatedly, when calculating episodic specificity scores (which account for differences in overall memory length), we found that the proportion of internal details generated by the young adults was higher than the middle-aged/older adults, which was an outcome that did not significantly differ across groups varying in race/ethnicity and/or bilingualism, or the use of Spanish memories in the bilinguals. Our results align closely with most studies in the episodic autobiographical memory literature that find reduced episodic detail generation in older adults relative to young adults using predominately non-Hispanic White samples, or samples of unreported race/ethnicity (Levine et al., 2022; Schacter et al., 2007; Schacter et al., 2013; Grilli et al., 2018; Acevedo-Molina et al., 2019).

One noteworthy difference in our findings was the effect of older age on total detail. We found that middle-aged/older bilingual and monolingual Hispanics generated less detail relative to young Hispanics and young non-Hispanic Whites, as well as middle-aged/older non-Hispanic Whites. Typically, overall detail does not significantly differ between young and older adults, given that external details counterbalance the drop in episodic detail among older adults (Acevedo-Molina et al., 2019; Bluck et al., 2016; Levine et al., 2002). In fact, non-Hispanic White older adults in the present study did not significantly differ in total detail relative to young adults, indicating that our results replicate prior research with non-Hispanic White samples. This suggests that autobiographical memory narration may be more sensitive to age in Hispanics, although this effect appears not to be specific to episodic detail.

In sum, the present findings suggest that the often-found older age-related shift in internal and external detail extends to Hispanic individuals. This is an important finding for evaluating the sensitivity

of autobiographical memory testing to cognitively normal older age in Hispanic populations. However, among Hispanics, older age may be especially sensitive to overall detail provided, at least in the context of an autobiographical memory task that prompts individuals to remember episodic detail.

5.2. Is bilingualism associated with enhanced episodic autobiographical memory in Hispanics?

The present study is the first to investigate the influence of bilingualism on episodic specificity in young and older U.S. Hispanics. Relative to English monolingual Hispanics, English-Spanish bilingual Hispanics generated more internal details when describing memories in English. When describing memories in Spanish, however, bilingual Hispanics did not significantly differ from monolingual Hispanics for internal details. The monolingual versus bilingual groups also did not significantly differ in external details, regardless of whether we examined bilingual participants' memories in English or Spanish. When we examined specificity scores, bilingual Hispanics continued to show higher episodic richness in their memories relative to monolingual Hispanics. These findings, therefore, reveal evidence of a bilingualism advantage among Hispanics, especially when narrating memories in English.

Interestingly, when comparing bilingual Hispanics and non-Hispanics Whites, we found additional evidence of a bilingualism advantage. Non-Hispanic Whites generated more external details than bilingual Hispanics, and the groups did not differ on the amount of internal details generated. This can be viewed as indirect evidence of an advantage for bilingualism, as the task objective is to report internal, not external, detail. Whether bilingual Hispanics' memories were described in English or Spanish did not alter the results. Several additional analyses indicated that bilinguals might have a particular advantage for internal detail, despite the fact that bilingual Hispanics tended to generate less detail overall. For example, when examining specificity scores, we found that bilingual Hispanics' followed a "short and specific" pattern with their memories. That is, although they were less detailed,

bilingual Hispanics generated a higher proportion of internal details relative to monolingual non-Hispanics Whites. Critically, higher specificity in bilinguals was not driven by age regardless of whether bilingual Hispanics were compared to monolingual Hispanics or monolingual non-Hispanic Whites, suggesting that bilingualism enhances episodic autobiographical memory in older adults as well.

Although there is evidence of cognitive disadvantages that come with being bilingual (Fu et al., 2017; Folke et al., 2016; Runnquvist et al., 2013), benefits have also been noted. For instance, bilingualism has been viewed as a protective factor against neurodegenerative disorders, such as AD (Craik, Bialystok, & Freedman, 2010; Schweizer, Craik, Bialystok, 2013). Bilingualism has also been associated with better cognitive performance among individuals in the suspected prodromal stages of AD. For example, a recent study by Roselli and colleagues (Roselli et al., 2018), found that bilinguals with amnestic mild cognitive impairment (aMCI) demonstrated superior performance on selected verbal memory tasks, compared to monolinguals with aMCI. Similarly, a study by Ossher et al., 2013, found that bilinguals diagnosed with aMCI in a single domain were diagnosed at a later age than monolinguals, suggesting an early protective advantage of bilingualism against memory decline on standard neuropsychological tests of memory. Therefore, the present study adds to our understanding of the neuropsychological advantages of bilingualism on memory and suggest that some advantages are present in the realm of autobiographical memories.

Interestingly, some of the outcomes tied to bilingual Hispanics may reflect race/ethnicity to some degree. For instance, we found that episodic specificity was higher among monolingual Hispanics relative to non-Hispanic Whites, which was a race/ethnic outcome that did not significantly differ by age group. A possible explanation for why episodic specificity is higher among Hispanics relative to non-White Hispanics lies in the relationship between cognition and culture. Culture heavily influences the way we process information and remember the past (Park & Huang, 2010; Ji & Yap, 2016; Wang &

Ross, 2007; Ross & Wang, 2010). Culture also shapes the self, an essential component in autobiographical memory, and different cultures value different aspects of the self (Conway et al., 2004; Conway, 2005; Prebble et al., 2013; Wang & Conway, 2004; Markus & Kitayama, 1991). For instance, western cultures, like American culture, tend to value individualism and independence (unique attributes and qualities that a person identifies with). In contrast, other cultures, like East Asian culture, value interdependence (a person's role within the community and how you relate to others). Research examining the relationship between autobiographical memory and culture suggests that individuals from individualistic cultures exhibit greater episodic specificity in personal recollections than individuals from cultures that value interdependence (Wang, 2004; Wang & Brockmeier, 2002; Wang & Ross, 2005). Wang (Wang 2003, 2004) theorizes that individuals from individualistic cultures may be motivated to attend to and encode unique episodes that reinforce the self. In contrast, individuals from cultures that value interdependence may prioritize the retention of memories that will strengthen their relation to others and the community. Such memories require critical semantic knowledge to describe social harmony and collective solidarity.

In the context of our study, Hispanics living in the US, are influenced by two vastly different cultures. On the one hand, Hispanic culture values collectivism (Stone at al., 2006; Gallo et al., 2009), while American culture values individualism. Therefore, episodic autobiographical memory in Hispanics living in the US, potentially benefits from a combination of aspects valued by the two cultures. In other words, many U.S. Hispanics may encode and retrieve autobiographical memories through a blurred individualist and interdependent lens, resulting in highly rich and socially contextualized memories. Future work could more directly examine this possibility by investigating whether the topics of autobiographical memories shared by Hispanics differ from those of non-Hispanic Whites. For instance, perhaps Hispanics are more likely to share often-repeated autobiographical memories involving family

and friends relative to non-Hispanic Whites, who might be more inclined to share autobiographical memories about individual accomplishments or activities. In sum, our results demonstrate that assessing episodic autobiographical memory has the potential to be a culturally appropriate, age-sensitive memory measure among Hispanics. Interestingly, English monolingual Hispanics may tend to be more specific, but also less detailed overall, relative to English monolingual non-Hispanic Whites.

5.3. Is episodic autobiographical memory in Hispanics modulated by language at encoding/retrieval or inhibition?

We were interested in examining the relationship between language, inhibition, and episodic autobiographical memory. Contrary to our hypothesis, we found that a match or mismatch between the language at encoding and retrieval did not significantly influence episodic specificity among bilingual Hispanics. In other words, for episodic specificity, it did not matter whether the language spoken at the moment the memory happened matched the language used when the memory was retrieved. Our findings differ from an earlier study (Marian & Neisser, 2000), which found that a match between the language used at encoding and the language used at retrieval resulted in more specific memories. However, Marian and Neisser (2000) focused on the event significance of memories (e.g., memories from before or after immigration). The act of immigrating, therefore, may have been the more important factor. Also, the memories retrieved from our participants were not constrained to particular events but rather to life periods. Thus, it is possible that encoding specificity and transfers appropriate processing is driven by the phenomenological aspects of memories (i.e., personal relevance, emotion). However, this question should be addressed by future research.

Additionally, we found that episodic specificity did not predict performance on a measure of inhibition (i.e., Stroop test). There was, however, a significant interaction between age and bilingualism as predictors of inhibition. Surprisingly, when we assessed bilingualism status differences separately

for young and middle-aged/older adults, we found that middle-aged/older bilingual Hispanics had *worse* inhibition performance than middle-aged/older monolingual Hispanics. This effect was not statistically significant among young adults. Although we had expected bilingualism to be associated with an advantage in inhibition, our findings align with prior research that has not found a bilingual advantage on measures of inhibition (Kousaie & Phillips, 2012; Paap & Grennberg, 2013). Our results also differ from studies that suggest the bilingual advantage in executive functions is higher in older bilinguals (Bialystok et al., 2014; Gold et al., 2013). The primary theory behind the bilingual advantage in older bilinguals is that switching between two languages throughout life results in an executive advantage (Bialystok, 1999, 2010, 2011). Our results may be driven by sample characteristics of the bilingual sample, such as language dominance. Our bilingual sample primarily reported English as their dominant language. It is possible that our participants do not switch languages frequently, because of language preference and/or living in a primarily monolingual environment. Therefore, our results may not generalize to bilinguals that frequently switch between languages (Tao et al., 2015).

If not inhibition/executive functioning, why might bilingualism be associated with higher specificity while describing autobiographical memories? It is important to note that all participants spoke English fluently. The addition of Spanish as a fluent language is therefore directly tied to bilingualism. Could there be a specific autobiographical memory advantage associated with the Spanish language? According to Llabre, (Llabre et al., 2021) Spanish language can play a potent role in certain aspects of psychological health and wellbeing, including the Hispanic Health Paradox, which refers to Hispanics in the United States having lower mortality rates from cardiovascular disease and other mortality-related causes than their non-Hispanic White counterparts despite having a worse risk-factor profile (Markides & Coreil, 1986; Ruiz et al., 2013). It is hypothesized that the advantage of the Spanish language may be partly explained by an abundant emotional lexicon, which may be conducive to greater expression

of emotion in social contexts. However, it is important to note that emotional expression is influenced by various factors, including cultural norms, individual differences, and social contexts, rather than the language itself (Mesquita & Fridja, 1992; Markus & Kitayama, 1991). For instance, some cultures may encourage more overt displays of emotions, while others may value emotional restraint or moderation (Kitayama et al., 2006). These cultural differences can influence how emotions are expressed and perceived within a specific language community. The Spanish language, therefore, may promote easy expression in social interactions, which may influence episodic autobiographical memory by facilitating talking about and sharing personal events.

While the influence of valence and emotion of the Spanish language has not been examined in the context of autobiographical memory, emotion is an essential component of autobiographical memory (Conway & Pleydell-Pearce, 2000; St. Jacques & Levine, 2007; Talarico et al., 2004; Holland & Kensinger, 2010; Comblain et al., 2005). Emotional events, both positive and negative, tend to be remembered more vividly and with greater detail compared to neutral events (Kensinger, 2009; Berntsen & Rubin, 2002). Cultural factors, including language and social norms, can shape the emotional experiences and memory processing in different populations (Fivush et al., 2011). Cultural values and expectations regarding emotions may influence how valence impacts autobiographical memory in Spanish-speaking individuals. For example, collectivistic cultural norms may emphasize the positive aspects of memories to maintain social harmony (Lim, 2016; Matsumoto et al., 2008). However, it is important to note that in our study, there was no difference between memories shared in English versus Spanish. Nevertheless, perhaps knowledge of the Spanish language serves as an enhancing factor in episodic autobiographical memory.

5.4. Additional considerations and conclusions.

Although the present study expands our understanding of how bilingualism and ethnicity influence episodic autobiographical memory, it raises questions that future studies should investigate further. For instance, although we measured multiple language variables using the LEAP-Q (Marian et al., 2007), we did not have a formal measure of acculturation for our Hispanic participants. Recent research examining neuropsychological performance in Hispanics has found that higher levels of acculturation are associated with better performance on neuropsychological measures across multiple domains (Mendoza et al., 2022; Alan et al., 2022; Rodríguez et al., 2022). Along the same lines, to ease participant burden in an online study, we did not collect data regarding lifestyle factors such as diet, alcohol intake, smoking, physical activity, social activity, and occupational complexity, all of which can affect memory in general (Celik et al., 2020; Raizada & Kishiyama, 2010). Moreover, the years of education a person has positively correlates with cognitive function throughout adulthood and predicts the risk of dementia late in life (Lovden et al., 2020; Andel et al., 2006; Stern, 1999). However, the *quality* of an individual's education is also important to consider, as it can also influence cognitive performance (Crowe et al., 2013; Barba et al., 2021). While we collected information about education from our participants (i.e., years of education), we do not have data regarding the quality of the education received by our participants. Thus, future studies should include a measure of the quality of education received. Lastly, we did not collect information about COVID-19 exposure from our participants. Recently, exposure to COVID-19 has been shown to compromise brain function and cognition, with individuals that recover from COVID-19 showing lower global cognition compared to healthy controls (Crivelli et al., 2022; Daroische et al., 2021; Houben et al., 2022).

To our knowledge, no studies have examined the relationship between episodic autobiographical memory and various cultural factors such as acculturation, literacy, and other lifestyle factors. Yet, the

results of our study suggest that at least one relevant factor, that is bilingualism, influences this type of memory. Of relevance, many individuals in our monolingual Hispanic cohort were likely not purely monolingual, as they may have studied another language in school or may have been indirectly exposed to Spanish or another language throughout their lives (Bice & Kroll, 2019). Therefore, future studies should use a more formal and objective measure to determine monolingualism in their participants, although Gollan and colleagues (Gollan & Acenas, 2004; Gollan et al., 2005) suggest that recruiting "pure monolinguals" is not advisable as foreign language study is often required in school.

Lastly, future research should examine the neural underpinnings of autobiographical memory among Hispanics, and in particular how bilingualism may influence the brain's organization of the memories of the self. Bilingualism has been associated with neural differences in brain structure and functional activation (Abutalebi, 2008; Abutalebi & Green, 2007; Mechelli et al., 2004; Olsen et al., 2015). For instance, learning a second language is associated with increased gray and white matter volume in areas such as the frontal lobes, the anterior cingulate cortex, the left inferior parietal lobule, and subcortical structures like the putamen (Abutalebi et al., 2012; Abutalebi et al., 2013; Gold et al., 2013). In studies using structural and functional MRI in the context of cognitive aging, bilingualism also has been associated with greater reserve (Anderson et al., 2021; Bialystok et al., 2012). However, how the link between bilingualism and brain functioning translates to autobiographical memory, in young or older adults, has yet to be explored.

Relatedly, structural and functional MRI studies have associated autobiographical memory retrieval with the hippocampus and its cortical connections, including the parahippocampal cortex, retrosplenial cortex, posterior cingulate cortex, medial prefrontal cortex, and inferior parietal lobe (Addis et al., 2007; Andrews-Hanna & Grilli, 2021; Hassabis et al., 2007; Maguire, 2001; Matijevic et al., 2022; Memel et al., 2020; Ryan et al., 2001; Schacter et al., 2012; Summerfield et al., 2010). Studies of

cognitive aging suggest that this same brain network is relied on in older age, although there may be a shift toward more gist-based processing regions (Grilli & Sheldon, 2022). Whether bilingualism is associated with structural or functional alterations that might account for the specificity advantage found in young and older Hispanics in the present study is an important question for future research. It is possible that Hispanic background also influences the neural underpinnings of autobiographical memory, which future research should explore. Similarly, future studies should also consider longitudinal designs, as they could provide valuable information regarding any differences in the trajectory of cognitive decline and age-related changes in episodic autobiographical memory among this population.

In summary, we examined the influence of bilingualism on autobiographical memory among young and middle-aged/older Hispanics and how other cognitive factors influence this relationship. We replicated and extended the often-found age-related reduction in episodic detail generation in Hispanics. We also showed that bilingual Hispanics' memories were more episodically specific than monolingual Hispanics and Non-Hispanic Whites, suggesting that bilingualism enhances episodic autobiographical memory. This effect appears not to be driven by age. There also was an effect of ethnicity, with monolingual Hispanics being more specific relative to monolingual Non-Hispanic Whites in some respects. However, our findings do not suggest that non-Hispanic Whites' memories are not episodically specific, but rather that they are not *as* specific relative to Hispanics. Moreover, we found that the language used at encoding versus language used at memory retrieval was not associated with episodic specificity. Lastly, contrary to our hypothesis, we found that episodic specificity did not predict performance on an inhibition task and that middle-aged/older bilingual Hispanics had worse inhibition overall. Future studies could examine the relationship between cultural variables, like acculturation, and autobiographical memory.

Supplemental Materials

A. Phenomenological ratings from narrated memories

Table 1. Mean phenomenological ratings from the Autobiographical Interview reported by Hispanics

Question	Bilingual Hispanics	Monolingual Hispanics	*p*
Visualization	5.1(0.71)	5.5(0.21)	.12
Emotion	5.5(0.28)	4.8(0.28)	.13
Personal Importance *Now*	5.0(0.77)	5.0(0.42)	.94
Personal Importance *Then*	4.3(0.49)	4.5(0.71)	.62

*Note: Standard deviations are in parentheses.

B. De-identified examples of memories narrated by participants

a. Example from a young Bilingual Hispanic adult

i. *"I remember my father, my mother, my sister, and I were at the mall, and I accidentally tripped over my sister's stroller, and she was like hanging from the stroller. This happened in front of the [name of store] store, and my mother was really mad at me and wanted to yell at me, but she didn't. My father was mad too. It was funny, though. I don't think I did it on purpose; at least, that's what I think. But it was really funny, and the baby was like hanging from the stroller."*

b. Example from a middle-aged/older non-Hispanic White adult

i. *"When I was a junior in high school, I was – I was typically, typically kind of shy in high school, a little bit introverted. But I was - I had been taking ballet for many years, so I was pretty um physically um apt and so I uh I decided I wanted to try out for the uh cheerleading team that would be selected. And I can still remember the dress I wore at try-out and how thrilled I was - I was uh I was a little bit nervous but I was more excited about um trying out, kind of surprised me that I*

wasn't more scared and um I remember how my routine went and I did a – at – I remember at the end I did a cartwheel into the splits and um remember getting you know people clapped and seemed excited and I did make it on the team so um yes I still remember what the gym looked like and it was pretty full and that I had this navy blue floral dress on uh to try out um. I don't remember how I did my hair or anything like that. Uh. That's about all I remember. I can still remember some of the steps of that routine, too. Just things that I did. Um. Yes. And just I remember feeling very proud."

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