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# Comparing working memory in bilingual and monolingual Hispanic/Latino preschoolers with disruptive behavior disorders



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### ABSTRACT

The current study examined differences in working memory (WM) between monolingual and bilingual Hispanic/Latino preschoolers with disruptive behavior disorders (DBDs). A total of 149 children ( $M_{\text{age}} = 5.10$  years,  $SD = 0.53$ ; 76% male) with elevated levels of DBDs, as indicated by their parents or teachers, were recruited to participate in an 8-week summer program prior to the start of kindergarten (Summer Treatment Program for Pre-Kindergarteners). Prior to the start of treatment, parents completed several measures about their children's behavior and executive function, and children were administered two subtests of the Automated Working Memory Assessment to examine their current WM capabilities. After controlling for demographic variables (i.e., age, sex, socioeconomic status, IQ, and diagnostic status), no significant differences were observed between bilingual and monolingual children in verbal WM performance ( $\beta = .03$ ,  $p > .05$ ). However, children who were bilingual did perform better than monolinguals on spatial WM tasks ( $\beta = .23$ ,  $p < .01$ ). Finally, parent reports of WM corroborated these findings such that bilingual children were reported as having fewer WM problems by parents ( $\beta = -.19$ ,  $p < .05$ ) and teachers ( $\beta = -.22$ ,  $p < .05$ ). Whereas WM deficits are often found among children with DBDs, the current findings suggest that bilingualism may serve as a protective factor for preschoolers with DBDs.

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## Introduction

The transition from preschool to kindergarten is an important milestone in a child's life, often labeled as a "sensitive period" for determining later school success (Rimm-Kaufman & Pianta, 2000). A critical component of early school success is a child's executive function (EF) abilities (Blair, 2002), which refers to higher-order mechanisms necessary for the self-regulation of emotions, thoughts, and actions (Zelazo et al., 2003). These neurocognitive processes typically include inhibition, working memory (WM), and cognitive flexibility/task shifting (Blair & Razza, 2007). Of particular interest to the current study was preschoolers' WM abilities. WM is typically conceptualized as the short-term retention of information during the active manipulation of such information (Baddeley, 1986; Gathercole, Pickering, Ambridge, & Wearing, 2004).

WM is composed of the central executive, which controls how resources are allocated between two subsystems: the visuospatial sketchpad and the phonological loop (Baddeley, 2007; Baddeley & Hitch, 1974; Swanson, 2011). Both verbal and spatial WM deficits have been implicated in children's behavioral and academic functioning (Alloway, Gathercole, Kirkwood, & Elliott, 2009; Aronen, Vuontela, Steenari, Salmi, & Carlson, 2005; Gathercole, Brown, & Pickering, 2003). For example, children with better WM performance tend to score higher on academic achievement scores (Barker, 2016; Owens, Stevenson, Norgate, & Hadwin, 2008) and have better social outcomes (i.e., better liked by peers and teachers; de Wilde, Koot, & van Lier, 2016). More specifically, during the preschool period, spatial WM abilities are highly associated with performance on mathematical tasks because these tasks are underscored by the emerging ability to visually represent numbers (Rasmussen & Bisanz, 2005). Verbal WM abilities, on the other hand, are associated with language and early literacy skills (Blything & Cain, 2016). Hence, identifying factors that promote WM abilities in young children has significant implications for children's school readiness (Tsetlin et al., 2012).

### *Working memory and language*

Given the increased number of minority children in the U.S. population (Carlson & Meltzoff, 2008; La Greca, Silverman, & Lochman, 2009), more recent efforts have focused on the influence of language on the development of various executive functions, including WM, by comparing bilingual and monolingual children (Bialystok, 2011a, 2011b). A growing body of literature suggests that there is an association between neurocognitive factors and bilingualism. For example, a previous systematic review identified small to large positive effect sizes between bilingualism and several neurocognitive factors such as attentional control, metalinguistic awareness, and WM (Adesope, Lavin, Thompson, & Ungerleider, 2010). Furthermore, a study by Morales, Calvo, and Bialystok (2013) showed that 5-year-old bilingual children were comparable to 7-year-old monolingual children on their performance during a visuospatial WM task. More recently, Lonigan, Lerner, Goodrich, Farrington, and Allan (2016) found that preschoolers proficient in English and Spanish outperformed primarily Spanish-speaking preschoolers across several domains of EF such as inhibitory control and verbal WM. However, it is important to note that the literature does remain mixed given that several studies have not replicated similar benefits of bilingualism. For example, Namazi and Thordardottir (2010) found no differences in attentional control during a Simon task among children who were French–English bilinguals and those who spoke either only French or only English. In addition, a longitudinal study following children from kindergarten to second grade failed to find any benefits in verbal WM among children with prolonged exposure to a second language (Engel de Abreu, 2011).

Given the aforementioned mixed empirical evidence, it is not surprising that there are several mechanistic theories proposed to explain the link between bilingualism and neurocognitive functioning. On the one hand, children who are bilingual may have an underdeveloped phonological loop due to the difficulty in switching between languages (Bialystok, Luk, Peets, & Yang, 2010; Ivanova & Costa, 2008). On the other hand, from a multiple-resource model, the repeated rehearsal/switching between the dominant and secondary languages' lexical schemas may enhance the central executive, arguably

the most critical component of WM (Bialystok & Craik, 2010). There is also evidence to suggest that bilingual individuals actively monitor and provide joint attention to both the target language and the non-target language, which further enhances the central executive (Kroll, Dussias, Bogulski, & Valdes Kroff, 2012). However, as pointed out by Soliman (2014), the modality in which one measures WM can significantly affect which of the two subsystems (i.e., phonological loop or visuospatial sketchpad) is engaged and subsequently the link with bilingualism.

Verbally mediated WM tasks (e.g., listening recall) are more likely to activate the phonological loop, whereas more abstract/pattern-mediated tasks (e.g., block recall) are more likely to activate the visuospatial sketchpad (Blom, Küntay, Messer, Verhagen, & Leseman, 2014). Past work has documented that bilinguals have a more limited vocabulary in both languages and lexical representation (Greenberg, Bellana, & Bialystok, 2013; Luo, Luk, & Bialystok, 2010), which may affect their efficiency in engaging the phonological loop but not the visuospatial sketchpad (Soliman, 2014). Thus, theoretical support exists for the notion that the potential benefits of bilingualism on WM would be more pronounced in nonverbal tasks. However, limited studies have examined both verbal and nonverbal WM tasks within a bilingual sample of young children. In addition, the link between bilingualism and potential WM benefits may be further complicated by the consideration of WM impairments that may be due to other factors such as an underlying neurodevelopmental disorder.

### *Working memory and disruptive behavior disorders*

The most common neurodevelopmental disorder during early childhood is attention-deficit/hyperactivity disorder (ADHD; Rowland, Lesesne, & Abramowitz, 2002). Deficits in EF are a hallmark feature of ADHD as well as other disruptive behavior disorders (DBDs) such as oppositional defiant disorder (ODD; Oosterlaan, Logan, & Sergeant, 1998; Schoemaker, Mulder, Deković, & Matthys, 2013; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). Specifically, children with ADHD show significant deficits in WM when compared with typically developing (TD) peers (Cockcroft, 2011; Thorell & Wåhlstedt, 2006; Willcutt et al., 2005). For example, a meta-analysis by Martinussen, Hayden, Hogg-Johnson, and Tannock (2005) found large effects (Cohen's  $d = 1.06$ ), such that children with ADHD performed more poorly compared with TD children during tasks requiring the use of visual-spatial short-term memory. Although weaker in magnitude, children with ODD also show impairment in WM (Rhodes, Park, Seth, & Coghill, 2012). Given the overlap between ADHD and ODD (Connor, Steeber, & McBurnett, 2010), it is not surprising that impairments in WM tend to be amplified in school-aged children with a comorbid presentation (Rhodes et al., 2012). Although less work has examined WM in young children with DBDs, a recent meta-analysis of preschoolers with DBDs identified a small effect size (0.17) for WM deficits (Schoemaker et al., 2013).

It is important to note that rates of DBDs, and potentially underlying WM deficits, are not uniform across cultural groups. For example, several large-scale studies have documented that children who are Hispanic/Latino are less likely to be diagnosed with ADHD compared with non-Hispanic/Latino Black children and non-Hispanic/Latino White children (Morgan, Staff, Hillemeier, Farkas, & Maczuga, 2013; Pastor & Reuben, 2008; Visser et al., 2014). On the other hand, Hispanic/Latino children are more likely to be referred to special education by teachers compared with White children (Rimm-Kaufman, Pianta, & Cox, 2000). Therefore, it is difficult to determine whether Hispanic/Latino children are engaging in more DBDs compared with White children (Huaqing Qi & Kaiser, 2003) or whether such differences may be due to cultural expectations of appropriate child behavior (Vega & Alegría, 2001) and/or teacher bias (Ready & Wright, 2011). However, it is important to note that only one study, to our knowledge, has examined the association of bilingualism and DBDs and found that bilingual children had better behavioral trajectories compared with their English monolingual peers (Han & Huang, 2010). Of note, that study examined only the association between non-Hispanic White children and children from Asian countries (e.g., Thailand, Vietnam, Cambodia). Further examining the association between bilingualism and WM within a clinical sample of Hispanic/Latino children with DBDs is especially important given that Latinos/Hispanics represent the fastest growing minority group of children in the United States (e.g., 25% of kindergarteners; DeNavas-Walt, Proctor, & Smith, 2010).

### *The current study*

The goal of the current study was to examine whether bilingual status was associated with EF functioning, primarily WM, in a clinical sample of Hispanic/Latino preschoolers at risk for or diagnosed with a DBD. We were also interested in examining the association between DBD symptomology (i.e., ADHD vs. ODD symptoms) and bilingual status. Data were collected from the children, their parents, and their preschool teachers. Children completed a WM assessment that assessed both their visuospatial and verbal WM abilities. Parents and teachers filled out rating scales regarding the children's DBD symptoms and WM difficulties. We hypothesized that bilingual preschoolers would be rated by parents and teachers as having fewer DBD symptoms than monolingual children. Lastly, we hypothesized that bilingual children would outperform monolingual children in objective measures of WM and have fewer WM difficulties as reported by parents and teachers.

## **Method**

### *Participants and recruitment*

This study was conducted at a large urban university in the southeastern United States with a large Hispanic/Latino population. Children and their caregivers were recruited across four summers from local preschools and mental health agencies via brochures, radio and newspaper ads, and open houses/parent workshops for participation in an 8-week summer program prior to the start of kindergarten (Summer Treatment Program for Pre-Kindergarteners (STP-PreK) (Graziano, Slavec, Hart, Garcia, & Pelham, 2014). To qualify for the study, children were required to (a) have an externalizing problems composite *t*-score of 60 or higher on the parent ( $M = 65.21$ ,  $SD = 12.03$ ) or teacher ( $M = 65.17$ ,  $SD = 12.77$ ) Behavior Assessment System for Children 2 (BASC-2; Reynolds & Kamphaus, 2004), (b) be enrolled in preschool during the previous year, (c) have an estimated IQ of 65 or higher ( $M = 91.63$ ,  $SD = 14.67$ ) on the Wechsler Preschool and Primary Scale of Intelligence–Third Edition (WPPSI-III; Wechsler, 2002) or WPPSI–Fourth Edition (WPPSI-IV; Wechsler, Scales, & Index, 2012), (d) have no confirmed history of autistic or psychotic disorder, and (e) be able to attend an 8-week summer program prior to the start of kindergarten (See Graziano et al., 2014 for full program details).

Consistent with past work, and in an effort to reduce the effect of ethnicity on bilingualism and study outcomes (Kempert & Hardy, 2015), the current study excluded children identified by their parents as non-Hispanic/Latino ( $n = 60$ ) from the larger study sample ( $N = 209$ ). The final sample consisted of 149 Hispanic/Latino preschoolers ( $M_{\text{age}} = 5.10$  years; 76% male) with at-risk or clinically elevated levels of DBDs whose parents provided consent to participate in the study. Demographic information provided by parents (e.g., parental educational level, occupation, marital status, sex) was also used to calculate a Hollingshead Four Factor Index of Social Status as a measure of socioeconomic status (SES; Hollingshead, 1975). Hollingshead SES scores were in the lower- to middle-class range ( $M = 42.77$ ,  $SD = 12.66$ ).

### *Study design and procedures*

The study was approved by the university's institutional review board. Children in the current study also participated in a summer treatment program for pre-kindergartners (STP-PreK). Results of an open trial and a randomized trial of the STP-PreK are reported elsewhere (Graziano et al., 2014). For the current study, only pretreatment data were used to examine the association among bilingualism, WM, and behavioral functioning.

As part of the pretreatment assessment, consenting caregivers brought their children to the laboratory on two occasions. During the first visit, children were individually administered the WPPSI-III (Wechsler, 2002) or the WPPSI-IV (Wechsler et al., 2012), while consenting caregivers completed one of two structured diagnostic interviews (Diagnostic Interview Schedule for Children–Version IV [DISC-IV; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000] or Kiddie Disruptive Behavior Disorders Schedule [K-DBDS; Keenan et al., 2007]). Eligible participants were invited to attend the second

laboratory visit, where children were administered several assessments along with observational tasks to assess their WM and social-emotional development.

### Study measures

#### Bilingualism

Parents reported on their children's language abilities. Children were classified as bilingual ( $n = 95$ ) if English and Spanish were spoken to them at home and if the children also spoke both languages. Children were classified as monolingual ( $n = 54$ ) if they were spoken to only in English and spoke only English. Only 9 children were classified as Spanish-only monolinguals (i.e., spoken to and speaking exclusively Spanish). Given the low base rate, these children were excluded from analyses.

In an effort to validate parent reports of child bilingualism, 5-min parent-child interaction videos were coded for child language use by undergraduate research assistants blind to parent reported bilingual status. Videos for 5-min free-play parent-child interactions were available for 99 children (66% of the sample). Coders itemized the number of words spoken in English and Spanish by the parent and child during the 5-min free-play interaction and calculated proportions of language spoken in English and Spanish. Analyses of the coding data revealed that parents who reported their children as bilingual spoke significantly more in Spanish during the parent-child interactions ( $M = .26$ ,  $SD = 0.39$ ) compared with parents who reported their children as monolinguals ( $M = .05$ ,  $SD = .18$ ),  $t(96) = -2.51$ ,  $p < .05$ , Cohen's  $d = 0.69$ . Similarly, children who were reported by their parents as bilingual had significantly higher proportions of Spanish language use ( $M = .21$ ,  $SD = .37$ ) than children who were reported by parents as monolingual ( $M = .01$ ,  $SD = .01$ ) during the parent-child interaction,  $t(73.12) = -4.81$ ,  $p < .001$ , Cohen's  $d = 0.76$ . Of note, given that equal variances in Spanish language use could not be assumed between the bilingual and monolingual groups ( $F = 46.98$ ,  $p < .001$ ), the  $t$  value and accompanying degrees of freedom reported account for inequality of variances. In addition, children who were reported as bilingual by parents ( $M = 89.86$ ,  $SD = 15.01$ ) were comparable to children who were reported as monolinguals ( $M = 89.13$ ,  $SD = 19.19$ ) on the verbal comprehension index of the WPPSI-IV,  $t(123) = -0.19$ ,  $p = .85$ . Taken together, objective data show that while children classified as bilinguals have comparable levels of English proficiency, they are significantly more likely to speak and be spoken to in Spanish when interacting with their parents compared with monolinguals, thereby providing initial validity for parent-reported bilingualism.

#### Working memory

Children were individually administered the Automated Working Memory Assessment (AWMA; Alloway, 2007). The AWMA is a PC-based assessment of WM skills for children and adults aged 4–22 years. For the purposes of the current study, performance across two subtests was analyzed: Listening Recall (auditory WM) and Mister X (visuospatial WM). In the Listening Recall task, children were first asked to judge the validity of a sentence (true/false) and then asked to indicate the last word in the sentence. In the Mister X task, children were presented with two similar cartoon figures, each holding a ball in one hand. One of the figures was rotated between 45 and 315 degrees. Children were first asked to make a judgment about the spatial orientation of the figures (i.e., “Are they holding a ball in the same or different hands?”) and then asked to recall the location of the rotated figure's ball from six possibilities. Raw scores were converted to standard scores using gender and age norms. The AWMA has adequate test-retest reliability (.76–.81; Alloway, Gathercole, & Pickering, 2006) and has demonstrated discriminant validity by distinguishing children with exclusive difficulties in WM from children with disruptive behavior problems on behavioral rating scales of WM function (e.g., Behavior Rating Inventory of Executive Function [BRIEF; Gioia, Isquith, Retzlaff, & Espy, 2002]) and academic measures (e.g., Wechsler Intelligence Scale for Children–Fourth Edition [WISC-IV fluid intelligence; de Abreu, Conway, & Gathercole, 2010]).

Parents and teachers completed the BRIEF-Preschool Version (BRIEF-P; Gioia, Espy, & Isquith, 2003). The parent and teacher versions contain 63 items rated on a 3-point Likert scale (*never*, *sometimes*, or *often*) that yield five non-overlapping but correlated clinical scales (inhibit, shift, emotional control, working memory, and plan/organize). The BRIEF-P has well-established internal consistency, reliability, and validity (Isquith, Gioia, & Espy, 2004; Mahone & Hoffman, 2007). For the purposes of

the current study, the WM index *t* score was used as our parent and teacher measure of WM, with higher scores indicating poorer WM skills.

Behavioral functioning

Parents and teachers completed the Disruptive Behavior Disorder Rating Scale (DBD Rating Scale; Pelham, Gnagy, Greenslade, & Milich, 1992). Each symptom of ADHD and ODD on the DBD Rating Scale is rated on a 4-point scale with respect to the frequency of occurrence (*not at all, just a little, pretty much, or very much*). For the purposes of this study, the mean for ADHD symptoms (hyperactivity/impulsivity and inattention) and ODD symptoms was used ( $\alpha = .85-.86$ ).

Data analysis plan

All analyses were conducted using the Statistical Package for the Social Sciences (SPSS, version 20.0). According to Little's Missing Completely at Random Test, there was no evidence to suggest that the data were not missing at random,  $\chi^2(359) = 380.67, p = .21$ . All available data were used for each analysis. Preliminary analyses examined the extent to which bilingual and monolingual children differed on demographic variables (e.g., age, sex, SES, IQ, diagnostic status). Next, hierarchical regressions were conducted to examine the extent to which bilingual status was associated with EF (standardized performance based on the AWMA and parent report based on the BRIEF-P) as well as with behavioral functioning (parent-reported ADHD and ODD symptoms).

Results

Preliminary analyses

Preliminary correlations between all study variables are presented in Table 1. Descriptive statistics are presented in Table 2 for the overall sample as well as by bilingual status group. Analysis of demographic variables revealed that bilingual preschoolers tended to come from families with marginally

Table 1  
Correlations between study variables.

|                                        | 1     | 2    | 3      | 4     | 5     | 6    | 7     | 8     | 9    | 10    | 11    | 12 |
|----------------------------------------|-------|------|--------|-------|-------|------|-------|-------|------|-------|-------|----|
| 1. Bilingual status                    |       |      |        |       |       |      |       |       |      |       |       |    |
| 2. SES                                 | -.14  |      |        |       |       |      |       |       |      |       |       |    |
| 3. BRIEF WM (P)                        | -.19* | .06  |        |       |       |      |       |       |      |       |       |    |
| 4. BRIEF WM (T)                        | -.22* | .22* | .41**  |       |       |      |       |       |      |       |       |    |
| 5. AWMA Verbal WM (O)                  | -.01  | .05  | -.17   | -.15  |       |      |       |       |      |       |       |    |
| 6. AWMA Spatial WM (O)                 | .23*  | .05  | -.15   | -.22* | .56** |      |       |       |      |       |       |    |
| 7. BF: DBD Inattention Symptoms (P)    | -.20* | .13  | .74**  | .33** | -.06  | -.05 |       |       |      |       |       |    |
| 8. BF: DBD Hyperactivity Symptoms (P)  | -.13  | .11  | .39**  | .07   | .06   | .05  | .70** |       |      |       |       |    |
| 9. BF: DBD ODD Symptoms (P)            | -.11  | .02  | .16    | -.15  | -.02  | .07  | .38** | .57** |      |       |       |    |
| 10. BF: DBD Inattention Symptoms (T)   | -.03  | .15  | .23**  | .75** | -.03  | -.12 | .19*  | .07   | -.15 |       |       |    |
| 11. BF: DBD Hyperactivity Symptoms (T) | .10   | .04  | -.09   | .22*  | .15   | .10  | .02   | .21*  | .00  | .48** |       |    |
| 12. BF: DBD ODD Symptoms (T)           | .07   | -.13 | -.23** | -.02  | .16   | .16  | -.20* | .02   | .19* | .19*  | .50** |    |

Note. SES, socioeconomic status; P, parent report; T, teacher report; O, observed measure; WM, Working Memory; BF, Behavioral Functioning; AWMA, Automated Working Memory Assessment; BRIEF, Behavior Rating Inventory of Executive Functioning–Preschool Version; DBD, Disruptive Behavior Disorder; ODD, Oppositional Defiant Disorder. Bilingual status is dummy coded, with bilingual children coded as 1 and monolingual children coded as 0. Of note, the only scale on the BRIEF-P associated with bilingualism across parent and teacher report was the Working Memory subscale.

\*  $p < .05$ .  
\*\*  $p < .01$ .

**Table 2**  
Descriptive statistics.

|                                                        | Whole sample (n = 149)<br>Mean (SD) | Bilingual children (n = 95) | Monolingual children (n = 54) | Cohen's d     |
|--------------------------------------------------------|-------------------------------------|-----------------------------|-------------------------------|---------------|
| AWMA Spatial Working Memory (O)                        | 91.04 (17.61)                       | 102.91 (19.59)              | 92.67 (16.91)                 | <b>0.56</b>   |
| AWMA Verbal Working Memory (O)                         | 87.37 (14.76)                       | 89.29 (12.21)               | 89.39 (17.24)                 | –0.01         |
| BRIEF Working Memory (P)                               | 71.14 (13.70)                       | 69.18 (13.85)               | 74.69 (12.80)                 | – <b>0.41</b> |
| BRIEF Working Memory (T)                               | 67.02 (12.99)                       | 65.40 (12.96)               | 71.83 (12.06)                 | – <b>0.52</b> |
| Behavioral Functioning: DBD Inattention Symptoms (P)   | 1.35 (0.69)                         | 1.25 (0.69)                 | 1.53 (0.67)                   | – <b>0.41</b> |
| Behavioral Functioning: DBD Hyperactivity Symptoms (P) | 1.60 (0.71)                         | 1.53 (0.69)                 | 1.73 (0.73)                   | –0.28         |
| Behavioral Functioning: DBD ODD Symptoms (P)           | 0.97 (0.63)                         | 0.91 (0.61)                 | 1.06 (0.66)                   | –0.24         |
| Behavioral Functioning: DBD Inattention Symptoms (T)   | 1.40 (0.73)                         | 1.39 (0.83)                 | 1.42 (0.74)                   | –0.04         |
| Behavioral Functioning: DBD Hyperactivity Symptoms (T) | 1.69 (0.79)                         | 1.75 (0.83)                 | 1.58 (.70)                    | 0.22          |
| Behavioral Functioning: DBD ODD Symptoms (T)           | 1.05 (0.79)                         | 1.09 (0.81)                 | 0.97 (0.75)                   | 0.15          |

Note. P, parent report; T, teacher report; O, observed measure; AWMA, Automated Working Memory Assessment; BRIEF, Behavior Rating Inventory of Executive Functioning–Preschool Version; DBD, Disruptive Behavior Disorder; ODD, Oppositional Defiant Disorder. Bolded values indicate significant difference at  $p < .05$  between bilingual children and monolingual children.

lower SES backgrounds ( $M = 41.46$ ,  $SD = 13.25$ ) when compared with monolingual children ( $M = 45.07$ ,  $SD = 11.28$ ),  $F(1, 147) = 2.84$ ,  $p < .10$ . Bilingual and monolingual children did not significantly differ on any other demographic variables (e.g., age, sex, diagnostic status; see Table 3). Thus, all subsequent analyses controlled for SES.

### Bilingualism and working memory

Relevant to the current study's research question, the association between bilingualism and both spatial and verbal WM performance was examined (see Table 4). Interestingly, no significant differences were observed between bilingual and monolingual children in verbal WM performance ( $\beta = .03$ ,  $p = .95$ ). On the other hand, regression analyses revealed that bilingual status was significantly

**Table 3**  
Sample demographics.

|                      | Whole sample (n = 149)<br>Mean (SD) | Bilingual children (n = 95) | Monolingual children (n = 54) | F score    | Cohen's d |
|----------------------|-------------------------------------|-----------------------------|-------------------------------|------------|-----------|
| Child age (years)    | 5.10 (0.53)                         | 5.08 (0.55)                 | 5.12 (0.52)                   | 0.34       | –.07      |
| SES                  | 42.77 (12.66)                       | 41.46 (13.25)               | 45.07 (11.28)                 | 2.84*      | –.29      |
| Child IQ             | 91.63 (14.67)                       | 92.00 (14.59)               | 90.98 (14.94)                 | 0.17       | .07       |
|                      | Percentage in sample                |                             |                               | Odds ratio | $\chi^2$  |
| Child sex (male)     | 75.60                               | 77.90                       | 81.10                         | 1.22       | 0.22      |
| ADHD-only diagnosis  | 25.50                               | 25.30                       | 25.90                         | 0.97       | 0.08      |
| ODD-only diagnosis   | 14.10                               | 17.90                       | 7.40                          | 2.72       | 3.41      |
| ADHD + ODD diagnosis | 47.00                               | 46.30                       | 48.10                         | 0.93       | 0.05      |

Note. SES, socioeconomic status; ADHD, attention-deficit/hyperactivity disorder; ODD, oppositional defiant disorder. Child IQ is based on Wechsler Preschool and Primary Scale of Intelligence–Third or Fourth Edition.

\*  $p < .10$ .

**Table 4**

Model for predicting working memory from bilingual status.

|                                        | $\beta$ | <i>t</i> Value | Model $R^2$ | $R^2$ change | <i>F</i> change |
|----------------------------------------|---------|----------------|-------------|--------------|-----------------|
| <i>AWMA Spatial Working Memory (O)</i> |         |                |             |              |                 |
| Step 1. SES (P)                        | .07     | 0.80           | .02         | .02          | 0.29            |
| Step 2. Bilingual status (P)           | .23**   | 2.64           | .06         | .05          | 6.95**          |
| <i>AWMA Verbal Working Memory (O)</i>  |         |                |             |              |                 |
| Step 1. SES (P)                        | .05     | 0.51           | .05         | .05          | 0.26            |
| Step 2. Bilingual status (P)           | .01     | 0.01           | .00         | .00          | 0.00            |
| <i>BRIEF Working Memory (T)</i>        |         |                |             |              |                 |
| Step 1. SES (P)                        | .22*    | 2.34           | .05         | .05          | 5.50*           |
| Step 2. Bilingual status (P)           | -.21*   | -2.27          | .09         | .04          | 5.15*           |
| <i>BRIEF Working Memory (P)</i>        |         |                |             |              |                 |
| Step 1. SES (P)                        | .03     | 0.38           | .06         | .00          | 0.49            |
| Step 2. Bilingual status (P)           | -.19*   | -2.28          | .20         | .04          | 5.20*           |

Note. P, parent report; T, teacher report; O, observed measure; SES, socioeconomic status; AWMA, Automated Working Memory Assessment; BRIEF, Behavior Rating Inventory of Executive Functioning–Preschool Version. Bilingual status is dummy coded, with bilingual children coded as 1 and monolingual children coded as 0.

\*  $p < .05$ .

\*\*  $p < .01$ .

associated with spatial WM performance ( $\beta = .23$ ,  $p < .01$ ), such that bilingual children had higher scores on the spatial task of the AWMA.

When examining parent and teacher reports of WM, a similar pattern of results emerged. Results were corroborated by parents, with bilingual children being rated as having fewer WM problems on the BRIEF WM composite ( $\beta = -.19$ ,  $p < .05$ ). Similarly, bilingual children were rated by teachers as having fewer WM problems on the BRIEF WM composite ( $\beta = -.22$ ,  $p < .05$ ).

### *Bilingualism and behavioral functioning*

The association between bilingualism and behavioral functioning, as measured by parent- and teacher-reported symptoms on the DBD Rating Scale was also examined. As seen in Table 5, bilingual children were rated by parents as having fewer inattention symptoms ( $\beta = -.18$ ,  $p < .05$ ). However, bilingual status was not associated with parent-rated symptoms of hyperactivity/impulsivity or ODD or any teacher-rated measures of behavioral functioning (i.e., inattention, hyperactivity, ODD).

## **Discussion**

This is the first study, to our knowledge, to examine WM in a clinical sample of bilingual and monolingual Hispanic/Latino children. Our study revealed that bilingualism was positively associated with performance on a visuospatial WM task, yet there were no differences observed for a verbal WM task. Second, bilingual children in our study were also experiencing fewer WM problems as reported by parents and teachers. Lastly, bilingual children were reported by parents as having fewer inattention symptoms of ADHD compared with monolingual children. However, there were no differences on teacher reports of DBDs between children who were bilingual and those who were monolingual.

Consistent with results of the current cross-sectional study, work examining bilingualism in infants has shown that exposure to a second language is positively associated with the development of EF during early childhood (Kovács & Mehler, 2009). This may in part be due to increased proficiency in neural circuits such as the basal ganglia. For example, Stocco, Yamasaki, Natalenko, and Prat (2014) described how exposure to more than one language allows an individual to “practice” language shifting, which involves the training of the fronto-striatal loops. Thus, preschoolers who have been exposed to and are proficient in a second language may have strengthened circuits that are associated with cognitive control (Meck & Benson, 2002) exerted by the central executive (McNab & Klingberg,

**Table 5**

Model for predicting behavioral functioning from bilingual status.

|                                                               | $\beta$ | <i>t</i> Value | Model $R^2$ | $R^2$ change | <i>F</i> change |
|---------------------------------------------------------------|---------|----------------|-------------|--------------|-----------------|
| <i>Behavioral Functioning: DBD Inattention Symptoms (P)</i>   |         |                |             |              |                 |
| Step 1. SES (P)                                               | .13     | 1.54           | .02         | .02          | 2.38            |
| Step 2. Bilingual Status (P)                                  | -.18*   | -2.22          | .05         | .03          | 4.94*           |
| <i>Behavioral Functioning: DBD Hyperactivity Symptoms (P)</i> |         |                |             |              |                 |
| Step 1. SES (P)                                               | .11     | 1.36           | .01         | .01          | 1.85            |
| Step 2. Bilingual status (P)                                  | -.12    | -1.44          | .03         | .02          | 2.08            |
| <i>Behavioral Functioning: DBD ODD Symptoms (P)</i>           |         |                |             |              |                 |
| Step 1. SES (P)                                               | .02     | 0.26           | .00         | .00          | 0.07            |
| Step 2. Bilingual status (P)                                  | -.11    | -1.30          | .01         | .01          | 1.70            |
| <i>Behavioral Functioning: DBD Inattention Symptoms (T)</i>   |         |                |             |              |                 |
| Step 1. SES (P)                                               | .15     | 1.77           | .02         | .02          | 3.13            |
| Step 2. Bilingual status (P)                                  | -.01    | -0.10          | .02         | .00          | 0.01            |
| <i>Behavioral Functioning: DBD Hyperactivity Symptoms (T)</i> |         |                |             |              |                 |
| Step 1. SES (P)                                               | .04     | 0.50           | .00         | .00          | 0.25            |
| Step 2. Bilingual status (P)                                  | .11     | 1.27           | .01         | .01          | 1.62            |
| <i>Behavioral Functioning: DBD ODD Symptoms (T)</i>           |         |                |             |              |                 |
| Step 1. SES (P)                                               | -.13    | -1.51          | .02         | .02          | 2.29            |
| Step 2. Bilingual status (P)                                  | .05     | 0.62           | .02         | .00          | 0.38            |

Note. P, parent report; T, teacher report; SES, socioeconomic status; DBD, Disruptive Behavior Disorder. Bilingual status is dummy coded, with bilingual children coded as 1 and monolingual children coded as 0.

\*  $p < .05$ .

2008). Our findings highlight how the nature of a WM task, verbal or nonverbal, may explain the mixed literature on the potential advantages of bilingualism.

Results of the current study demonstrated that whereas there were no differences between monolingual and bilingual children in a verbal WM task (Listening Recall), there were significant differences, in favor of bilinguals, on a nonverbal WM task (Mister X). The Mister X task requires a moderate amount of cognitive flexibility because children need to identify whether a pair of stimuli are identical even when one of the stimuli is rotated. Similar to other studies that have used comparable nonverbal WM tasks (Bialystok & Martin, 2004), bilinguals' faster processing speed (Bialystok, Craik, Klein, & Viswanathan, 2004) and cognitive control (Bialystok & Viswanathan, 2009) have been positively associated with advantages in WM (Adesope et al., 2010). Nonverbal memory tasks, such as Mister X, Dot Matrix, and Odd-One-Out, elicit the activation of the visuospatial sketchpad (Bialystok et al., 2010), whereas verbal tasks, such as Listening Recall, require the phonological loop. Given that bilinguals have been shown to have a more limited vocabulary in both languages, this may explain the null findings for a bilingual advantage when verbal WM tasks are used.

Past work on WM outcomes has typically relied on standardized/observational methods to measure differences between bilingual and monolingual children (Diamond, 2013). Our current study expands such work by corroborating standardized findings with both teacher and parent ratings. Specifically, both parents and preschool teachers rated bilingual children as exhibiting fewer WM problems, on the BRIEF-P, with large to moderate effect sizes, respectively. When taking normative data into account and considering the clinical significance of the findings, it is important to note that whereas the mean WM problems *t* score for bilinguals fell in the subclinical range (mean *t* scores = 69.18 for parents and 65.40 for teachers), monolingual children's scores were within the clinically elevated range (mean *t* scores = 74.69 for parents and 71.83 for teachers). Of note, it is important to acknowledge recent work addressing limitations of the BRIEF-P teacher reports in measuring various components of EF (Spiegel, Lonigan, & Phillips, 2017). However, that same study indicated that the factors composed of items from the working memory and plan/organize subscales were the only ones related to an objective EF task (the Head-Toes-Knees-Shoulders task; McClelland et al., 2007). Post hoc analyses of the current study (see Note in Table 1) are consistent with Spiegel et al. (2017) in that

only the working memory subscale significantly differentiated children classified as bilingual from those classified as monolingual.

Items on behavior rating scales of EF such as the BRIEF-P also share a significant overlap with symptoms of DBDs (Schoemaker et al., 2012), most notably ADHD (Ezpeleta & Granero, 2015). Hence, our finding that children classified as bilinguals were reported by teachers and parents on the BRIEF-P as having fewer working memory difficulties may also be interpreted as evidence for bilinguals exhibiting fewer symptoms of ADHD. This interpretation is consistent with our DBD Rating Scale finding that bilingual children were rated by parents (but not teachers) as exhibiting fewer inattentive symptoms of ADHD compared with monolingual children. Thus, our findings indicate that preschool children who are bilingual may have not only greater WM abilities but potentially also cognitive control, as evident by fewer inattention symptoms of ADHD.

In terms of this study's limitations, it is first important to acknowledge our suboptimal assessment of bilingualism. Bilingualism was reported exclusively by parents, and children's verbal abilities were tested in only one language (English), thereby making it difficult to quantify children's proficiency in Spanish relative to children in the monolingual group. However, parent report of bilingualism was validated with a naturalistic observation in which parents were instructed to engage with their children in a play activity as they would at home. Consistent with previous work, children classified as bilingual had comparable measures of English verbal comprehension (Hoff et al., 2012) but were spoken to in greater proportions, and spoke in greater proportions, of Spanish versus English during the 5-min play period.

In addition, the standardized EF battery relied largely on one domain of EF, namely WM. The EF literature on early childhood is quite mixed on the extent to which EF domains can be reliably differentiated or are best accounted by a unitary EF construct (Garon, Bryson, & Smith, 2008). For example, Schoemaker et al. (2012) found a two-factor EF model (inhibition and WM) in a sample of preschoolers with DBDs. A similar two-factor EF model of inhibition and WM was documented on a TD sample of 3- to 5-year-olds (Miller, Giesbrecht, Müller, McInerney, & Kerns, 2012). Within a longitudinal study of 5-year-olds, Usai, Viterbori, Traverso, and De Franchis (2014) also found a two-factor model that distinguishes inhibitory control from working memory, whereas shifting and working memory could not be differentiated. On the other hand, several studies have documented a one-factor EF model during early childhood (Wiebe et al., 2011) while noting that inhibitory control, WM, and cognitive flexibility appear to be more reliably differentiated during later childhood (Blair, Zelazo, & Greenberg, 2005). Thus, from a unitary EF perspective, our findings may indicate a positive association between bilingualism and overall EF (perhaps not just specific to WM). Given our clinical sample of preschoolers with DBDs, it will be important for future work to more comprehensively assess multiple facets of EF in relation to bilingualism within a TD sample.

Given the cross-sectional nature of the current study, a longitudinal approach would further elucidate the extent to which bilingualism in preschool is advantageous to a general EF factor or specific to a certain dimension of EF during later childhood when measurement of different facets of EF becomes more reliable (Anderson, 2002; Best, Miller, & Jones, 2009). Finally, we were underpowered to examine any differences in WM and DBD symptoms among monolingual English, monolingual Spanish, and bilingual children. It may be the case that the monolingual Spanish children would have performed comparably to the monolingual English children on objective measures of WM. However, within the school setting, prior work has documented teacher bias in rating the behaviors of non-English-speaking students (Ryser, 2011). Thus, it may be the case that Spanish monolingual children would have been rated more poorly on the BRIEF-P and DBD Rating Scale by English-speaking teachers due to such bias and not necessarily due to an underlying EF deficit.

Despite these limitations, our study contributes to the literature by documenting a positive association between bilingualism and WM/EF in a clinical sample of ethnically diverse preschoolers. The malleability of WM/EF in young children has been an increasing area of clinical research given its associations with school readiness (Blair & Razza, 2007; Fitzpatrick & Pagani, 2012) and symptoms of numerous DBDs, most notably ADHD (Barkley, 2014; Willcutt et al., 2005). For example, multicomponent intervention programs for preschoolers at risk for or with DBDs have been effective in improving children's overall EF abilities, behavior problems, and language/academic outcomes (Biernan et al., 2008; Graziano & Hart, 2016; Pears, Kim, Healey, Yoerger, & Fisher, 2015). Thus, although more

longitudinal work is needed, being exposed to and learning a second language may be a naturalistic way to improve children's EF. It will also be important to examine the extent to which exposure and proficiency in a second language moderates treatment response. For example, different linguistic inputs and code switching may influence the speed at which children's EF skills improve during the course of an intervention. Finally, it will be important to isolate which components of EF may be most amenable to change among bilingual children compared with monolingual children.

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