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Comparisons of the Effects of Monolingual and Bilingual Exposure on Executive Functioning

Among Neurodevelopmentally Vulnerable Children

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Abstract

The purpose of this study is to examine levels of executive functioning among a group of children who were referred to a pediatric neuropsychology outpatient clinic, and to compare these executive functioning scores between children living in bilingual homes with children living in monolingual homes. One-hundred and fifty children (61% male, mean age = 10.3 years) referred to a pediatric neuropsychology clinic were grouped into 1 of 2 groups based on parent report: English-only homes (N=121, 61% male, mean age = 10.5 years) and bilingual homes (N=29, 61% male, mean age = 9.4 years). Executive functioning was assessed using the Working Memory Index of the Wechsler Intelligence Scale for Children (WISC-IV), Tests of Variables of Attention (TOVA), and parent- and teacher-ratings on the Behavior Rating Inventory of Executive Functioning (BRIEF). Results indicated that children from bilingual homes have less executive functioning impairment than children from English-only homes according to teacher-ratings of overall executive functioning. In contrast, groups did not differ on parent-ratings and performance-based measures (WISC or TOVA). These results, if replicated, may call for new norms in executive functioning assessment for bilingual exposed children along with supporting the value of a bilingual environment for the developing child.

Comparisons of the Effects of Monolingual and Bilingual Exposure on Executive Functioning Among Neurodevelopmentally Vulnerable Children

The examination of bilingualism and its effects on the cognitive development of children is a well explored topic in research. Initial thinking on this relation hinted at potential harmful effects on the developing child, but more recently there is a general consensus that there is more benefit than harm (Carlson & Meltzoff, 2008; Poulin-Dubois, Blaye, Coutya, & Bialystock, 2010). Even though there is a breadth of research on the advantages of bilingualism in normative samples of children, there is a lack of knowledge about bilingualism and its role in clinically-referred children. This study will explore the effects of bilingual exposure on executive functioning in a mixed sample of clinically-referred children.

Executive Functioning

Executive functioning is a term used to identify the processes necessary for planning and purposeful behavior (Anderson, 2002). This includes the ability to selectively attend to focal stimuli, inhibiting a prepotent response, ability to monitor a situation, and ability to manipulate incoming information. These processes also include managing tasks and the ability to make plans, along with coding the time and place of the receiving information in their working memory (Funahashi, 2001). A key component necessary for good executive functioning is working memory, which is defined as the part of memory where information is actively stored temporarily so that it can be manipulated and processed (Funahashi, 2001). This mechanism makes it possible for the information necessary for executive functioning to be processed.

In addition to the daily-life essentials, executive functioning has also been associated with mathematical skills in children. Bull and Scerif (2001) reported strong positive correlations between mathematical ability and executive functioning. St. Clair-Thompson and Gathercole

(2006) found that inhibition in 57 11- and 12-year-old children was linked to English, mathematics, and science achievements, and that working memory was associated with achievement in English and mathematics.

Much of the research pertaining to executive functioning has looked at the disability of executive functioning. In studies looking at executive functioning in mixed samples of clinically referred children, research has shown that these children present with more problematic executive functioning scores than control samples (Bodnar, Prahme, Cutting, Denckla, & Mahone, 2007; Isquith, Gioia, & Espy, 2004). As executive functioning is related to the frontal cortex which develops for a long period of time including through and past the period of adolescence, executive functioning impairment has been associated with various neuropsychological disorders such as attention-deficit/hyperactivity disorder (ADHD), learning disabilities, traumatic brain injuries, and obsessive compulsive disorder (OCD) (Bodnar et al., 2007; Gioia, Isquith & Guy, 2001).

In looking at the specific sample of children with ADHD, a wealth of research has demonstrated that children with ADHD are more likely to show impairments in executive functioning than control groups without ADHD (Pennington & Ozonoff, 1996; Seidman, Biederman, Faraone, Weber, & Ouellette, 1997; Seidman, Biederman, Monuteaux, Weber, & Faraone, 2000). Particularly, children with ADHD present with deficiencies in the executive functioning processes of inhibition and working memory (Bodnar et al., 2007). As children with ADHD are more likely to have lower performance of executive functioning, it creates the possibility for them to be more at risk for grade retention, learning disability, and lower academic achievement (Biederman et al., 2004).

Bilingualism and Executive Functioning

There have been several studies looking into a bilingual difference in children's executive functioning. Bialystok and Viswanathan (2009) found that bilinguals from Canada and India, who all spoke English and one other language, performed better on the executive functioning tasks of inhibitory control and cognitive flexibility than English monolinguals in Canada. One task was the Trail-Making-Test which can be used to assess working memory and shifting capabilities. The Trail-Making-Test required the children to first connect numbers in ascending order that were placed randomly on a page and then to alternate between ascending numbers and letters. A second task was an inhibitory task with different colored faces, where the child had to choose whether or not to respond depending on how the image of the face was presented. With both of these tasks, bilinguals performed faster than monolinguals (Bialystok & Viswanathan, 2009). Poulin-Dubois, Blaye, Coutya, and Bialystock (2011) conducted a study that looked at executive functioning in bilingual and monolingual toddlers. The results showed that there was a bilingual advantage on the executive functioning inhibition task of an adapted shape Stroop task, a finding that mirrors research with older bilingual children (Poulin-Dubois et al., 2011). Carlson and Meltzoff (2008) also found a bilingual advantage in inhibition tasks between bilingual children, children involved in a language immersion school, and monolinguals when controlling for language functioning and socio-demographic factors.

There has also been a small amount of psychological research looking into the levels of bilingualism. In a study comparing bilinguals, partial bilinguals, and monolinguals on metalinguistic tasks, Bialystock (1988) found that both bilingual groups performed better than monolinguals on tasks that involved high levels of executive control. The metalinguistic tasks included three different types of tasks: arbitrariness of language, concept of word, and syntax

corrections (Bialystock, 1998). Arbitrariness of language tasks included understanding that names for items were arbitrary and could be changed and then assessing that the child understood the change. An example would be calling the sun “moon” and the moon “sun” and then asking what the child would call the item in the sky at night. The concept of word task included identifying which items were words on a list and then defining what would classify as a word and why. The syntax correction task involved the researcher orally stating a sentence to the child with a grammatical error and having the child repeat the sentence back directly after the researcher. Children were scored positively if they corrected the grammatical error (Bialystock, 1988). Bialystock and Majumder (1998) expanded on this research looking at nonverbal tasks along with metalinguistic tasks. This study produced the same results with both bilingual groups performing better than monolinguals on metalinguistic tasks involving inhibition, but in non-verbal tasks the bilinguals performed significantly better than partial bilinguals and monolinguals. There was not a significant difference seen between the partial bilinguals and monolinguals on such tasks (Bialystock & Majumder, 1998).

Current Study

To date there are no current studies that have examined the role of bilingualism on executive functioning among clinically-referred children. The current study seeks to address this in the following ways. The first is to address the lack of information about bilingual difference and executive functioning in a clinically-referred sample. This study will examine whether children and youth who may be cognitively compromised may also see benefits in executive functioning from bilingualism and bilingual exposure. The second focus of this study is to extend the bilingual population to include different levels of proficiency in a second-language. In the study of the education of languages, the levels of bilingualism and type of bilinguals has

been a topic of research in order to better serve the various types of language learners. One area of study has looked at what is called heritage language learners (HLL). There is a need to classify language learners who do not necessarily have formal education in the language of their culture or family, but have various levels of exposure to the language. Maria Carreira (2004) explores the different types of HLLs and the various ways to classify them depending on their level of fluency and their connection with family background. HLLs can have various levels of fluency in their heritage language depending on their exposure level and use of the language. HLL is referring to a person who takes classes in their heritage language and therefore is not the specific terminology that will be used for this study. The term “heritage speaker” will be used to refer to the participants in the bilingual exposure group in order to not misrepresent any of the participants as the level of bilingualism between participants varies.

A better understanding of this ever growing population of heritage speakers and bilinguals is essential to continue sound neuropsychological practice and diagnosis to serve all patients. The main hypothesis for this study is that heritage speaker children seen in a pediatric neuropsychology clinic will have less impaired executive functioning skills than monolingual children seen in a pediatric neuropsychology clinic.

Method

Participants

Participants included 150 children ranging from age 3.5 to 19.08 years-of-age (63% male, mean age = 10.3 years), who were referred to a pediatric neuropsychology clinic. Children were divided into two groups based on parent report: English-only exposed (N=121, 61% male, mean age = 10.5 years) and heritage speakers (N=29, 61% male, mean age = 9.4 years), who were children exposed to English and at least one other language. The modal other language

identified was Spanish (59%). Other languages identified by heritage speakers were Hindi, Hebrew, Chinese, American Sign Language, Gujarati, Ibo (Nigerian dialect), and Russian. The modal diagnosis was ADHD (English-only = 67.8%, heritage speakers = 55.2%). Chi square analyses indicated no significant differences between groups on age sex or ADHD diagnosis (see Table 1).

Table 1

Descriptive Statistics of Language Exposure Groups

	English-only (n = 121)	Heritage Speakers (n = 29)
Age	10.5 (4.0)	9.4 (3.8)
Gender		
Male	61%	62%
Female	39%	38%
ADHD Dx	68%	55%

Measures

There were two types of measures used to assess executive functioning: performance based measures and parent- and teacher-ratings. The performance based measures included the Working Memory Index of the Wechsler Intelligence Scale for Children (WISC-IV; Wechsler, 2003) and the Tests of Variables of Attention (TOVA; Greenberg, 2007). The parent- and teacher-ratings came from the Behavior Rating Inventory of Executive Functioning (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2005).

Performance Based Measures. The Working Memory index of the WISC-IV involves the Digit Span and Letter-Number Sequencing subtests (Williams, Weiss, & Rolfhus, 2003). On the Digit Span subtest, the child needs to remember a series of numbers and repeat them back to the examiner either verbatim (Digits Forward) or in reverse sequence (Digits Backward). On the

Letter-Number Sequencing subtest, the child is read a series of numbers and letters and needs to recall the numbers in ascending order and the letters in alphabetical order. On both subtests, the series of numbers/letters gradually increase in quantity (Williams, Weiss, & Rolfhus, 2003). The TOVA is a computer-based, objective test of attention in which children need to press a key when a target stimulus is projected and inhibit a response when the target stimulus is not presented. The variables measured with the TOVA were errors of omission (inattention – when the child does not press the key for the target stimulus), commission (impulsivity – when the child presses the key for other stimuli that are not the target stimulus), response time, and variability of response time (consistency) (Greenberg, 2007). The WISC-IV and TOVA both use standard scores with a mean of 100 and a standard deviation of 15. Higher scores mean better performance, and lower scores signify problems.

Parent- and Teacher- Report. The BRIEF is a standardized measure used to assess problematic executive functioning in the home and school environments with parent- and teacher-ratings. The BRIEF contains 86 items that divide into eight clinical scales and two validity scales. For this study, the scales used were *Inhibit* (e.g. “interrupts others”), *Shift* (e.g. “acts upset by a change in plans”), *Working Memory* (e.g. “when given 3 three things to do, remembers only the first and last), and the *Global Executive Composite* (Gioia & Isquith, 2004; Gioia, Isquith, Guy, & Kenworthy, 2005). These scales were chosen specifically because past research suggested a bilingual advantage in these areas of executive functioning. The *Inhibit* scale assesses a child’s ability to control or suppress impulsive behavior, while the *Shift* scale measures a child’s ability to adapt to deviations from routine or changing task demands (Gioia et al., 2005). As previously mentioned, the *Working Memory* scale measures the child’s ability to hold information in mind temporarily for active manipulation or processing (Funashashi, 2001,

Gioia et al., 2005). The *GEC* represents the composite score of executive function across all BRIEF scales. Ratings for the BRIEF are reported as T-scores with a mean of 50 and a standard deviation of 10. T-scores of 65 and higher are considered clinically significant, and higher scores suggest more executive functioning impairment.

Procedure

Data for this study were gathered through retrospective chart review of children and adolescents seen in a university-based outpatient neuropsychology clinic between January 2008 and May 2011. Sources of data included a developmental history form filled out by parents or guardians of the child being evaluated, the evaluation report, and the test protocols. If the child had been seen more than one time in the clinic, information from the first visit was used unless this evaluation was deemed inappropriate because the instruments used were of early editions or the original data were inaccessible because evaluations were completed prior to initiation of the electronic medical record system.

Results

One way ANOVAS were used for assess differences between language groups on BRIEF ratings, WISC-IV, and TOVA scores.

BRIEF Ratings

There were four scales of the BRIEF that were used to assess the executive functioning skills of the children: *Inhibition*, *Shift*, *Working Memory*, and the *Global Executive Composite* (GEC), with higher scores indicating higher impairment in executive functioning. There was a significant difference on teacher-reports for *Shift*, with the English-only mean = 68.02 ($SD = 19.78$), and the heritage speakers' mean = 56.80 ($SD = 8.95$), $F(1,77) = 8.04$, $p = .006$. There was also a significant difference on teacher-reports for *GEC*, with the English-only mean = 72.66

($SD = 15.83$), heritage speakers' mean = 61.93 ($SD = 11.46$), $F(1,77) = 6.11$, $p = .016$. There was no significant difference seen between groups for teacher-reports on inhibition [$F(1,77) = 3.23$, $p = .076$] or working memory [$F(1,76) = 3.78$, $p = .056$] (see Table 2).

Table 2

Teacher-Rating BRIEF Scores and Statistics

BRIEF Measures	English-only		Heritage speakers		<i>F</i>	<i>p</i>	η^2
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Inhibit	65.91	18.17	56.80	15.16	3.23+	.076	.042
Shift	68.02	19.78	53.13	8.95	8.04**	.006	.094
Working Memory	74.16	13.83	66.67	11.44	3.78+	.056	.047
GEC	72.66	15.83	61.93	11.46	6.11*	.016	.076

Note. + $p < .10$; * $p < .05$; ** $p < .01$.

The parent-report BRIEF scores did not show a significant difference between English-only and heritage speaker groups for any of the four measures (see Table 3).

Table 3

Parent-Rating BRIEF Scores and Statistics

BRIEF Measures	English-only		Heritage speaker		<i>F</i>	<i>p</i>	η^2
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Inhibit	63.04	15.70	58.58	15.96	1.58	.211	.015
Shift	60.19	14.17	55.00	13.64	2.68	.104	.020
Working Memory	68.24	12.47	63.88	15.18	2.22	.138	.019
GEC	66.35	12.53	60.70	14.85	3.63	.059+	.027

Note. + $p < .10$

WISC-IV and TOVA Scores

Assessment of executive functioning with performance-based measures demonstrated no significant difference between groups. On the WISC-IV Working Memory Index (WMI), English-only mean = 91.68 ($SD = 14.30$), and the heritage speakers' mean = 90.50 ($SD = 22.83$), $F(1,94) = .067$, $p = .797$. On the TOVA, groups did not significantly differ on any of the scales though the differences were all in the expected direction (see Table 4).

Table 4

Performance-Based Measures' Scores and Statistics

Performance-Based Measures	English-only		Heritage Speakers		<i>F</i>	<i>p</i>	η^2
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
TOVA							
Omission Errors	75.99	27.99	78.65	25.75	.131	.718	.001
Commission Errors	87.34	21.47	95.12	18.14	1.95	.166	.019
Response Time	87.78	22.62	93.53	14.06	1.02	.316	.010
Response Time Variability	77.47	23.94	85.59	15.22	1.80	.183	.018
WISC-IV							
Working memory	91.68	14.30	90.50	22.83	.067	.797	.001

Discussion

The hypothesis that heritage speaker children seen in a pediatric neuropsychology clinic would have stronger executive functioning skills than monolingual children seen in a pediatric neuropsychology clinic was partially supported. Teacher-ratings showed heritage speakers demonstrating fewer problems with executive functioning skills on the *Shift* scale and *Global Executive Composite* of the BRIEF, though there was no difference seen in parent-ratings or performance based measures. The teacher-ratings results line up with previous research that showed ample evidence of a bilingual advantage on executive functioning in children (Bialystok & Viswanathan, 2009; Poulin-Dubois et al., 2011; Carlson & Meltzoff, 2008), but these studies included samples of the general population where the current study focused on a heterogeneous sample of clinically referred children. It was expected and seen that many participants had impaired executive functioning scores as they were clinically referred children (Isquith, Gioia, & Espy, 2004), but even in the context of these impaired executive functioning scores a bilingual advantage was seen on the teacher-rating measure. It remains to be seen through replication whether the bilingual advantage seen in the general population could be applicable to other

populations such as clinically-referred children. Therefore, there may be a protective benefit to bilingual exposure in children otherwise vulnerable to weakness in executive functioning.

A limitation may be that assessing executive functioning from a neuropsychological perspective may not adequately capture the full range of this control process. For example, executive functioning assessments in a clinic generally focus on one aspect of executive functioning instead of looking at the big picture of executive functioning which is a complex, integrated system (Gioia & Isquith, 2004). In a clinical setting, it is not possible to fully simulate children's real-life environments that contain all the components and distractions (e.g. talking classmates, toys and books, television, adults, intercom announcements, etc.) that a child experiences when carrying out tasks using their executive functioning. These environmental distractions may cause executive functioning tasks to be more difficult. Teacher and parent reports, that assess children in these real-life environments and have a focus on many elements of their executive functioning instead of a specific aspect, may be more sensitive to individual differences in executive functioning than performance-based measures (Silver, 2000; Vriezen & Pigott, 2002). This may account for why in this study teacher-ratings indicated a difference between groups, whereas there was no difference seen with the performance-based measures.

There are a few possible interpretations as to why there was not a difference seen between groups on parent reports as there was for teacher reports. First, it may be that teachers observe children in a more uniform set of environments and expectations in the classrooms in comparison to the variety of home environments from which the parent reports come. Therefore the teacher-ratings across groups may be a comparison of more similar situations than the parent-ratings, allowing for the differences to become more apparent. Secondly, it may be that parents present a slight bias in their reports because of their concern for their child for whatever reason

they bring them to the clinic. This subconscious bias may not be seen in the teachers' reports as they may not have this specific concern for the child. Finally, had there been a difference between groups presented from the parent reports, there may have been a concern about whether or not this difference could be attributed fully to the language-exposure of the children or if cultural differences of the parents (specifically those of the heritage speakers) would have to be considered as possible confounding variables. Since the difference between groups was presented in the teacher reports, there is greater confidence that the difference is actually a difference between the children and not the raters.

The difference in the executive functioning scales that either did or did not show a significant difference between groups is also necessary to consider. The performance based measures were assessing working memory and inhibition and the parent- and teacher-ratings on the BRIEF contained these two scales as well. No significant difference between groups was seen on these two scales. Deficits in working memory and inhibition are highly associated with ADHD diagnoses, and the high representation of the ADHD diagnosis in this sample may account for why a difference between groups was not seen on these scales (Bodnar et al., 2007). The presence of less impairment seen for heritage speakers on the *Shift* scale may be associated with the fact that the children need to shift between two different languages in their environment. This increased engagement in shifting could strengthen their shifting capabilities (Poulin-Dubois et al., 2011).

It should be noted that there were conditions to this study that were not ideal. The small sample size, particularly of the heritage speaker group, was not ideal to assess a bilingual exposure effect on executive functioning. Also, the fact that the level of bilingualism could not be controlled in the heritage speaker group could affect the results as it has been seen that the

level of bilingualism can determine whether a bilingual difference is seen (Bialystock, 1988; Bialystock & Majumder, 1998). Finally, when working in clinical samples it is hard to control for all factors relating to diagnosis and developmental history. In particular for this study, there was a mixed sample of diagnoses that may have played a part in the outcomes of the executive functioning scores.

This current study supports the need to initiate future research on the topic of the effects of bilingual and monolingual exposure on executive functioning in clinically-referred children. Future research should include a larger sample with more control over the level of bilingualism in the children and their particular diagnoses. It may also be beneficial to continue to study how well parent and teacher reports and laboratory measures of performance seem to reflect the same underlying cognitive processes. Recent studies examining the differential relations of parent and teacher reports on attention and memory (Sesma, Wiik, Hermodson-Olsen, Ramstom, & Sesma, 2012) and ADHD subtype diagnoses (Ramstrom, Hermodson-Olsen, Sesma, Wiik, & Sesma, 2012) indicate that parents and teachers are each contributing unique information about child functioning.

Continued research in this area has great importance for several reasons. These studies begin to identify the questions that we need to investigate for the growing population of bilingual/multilingual exposed children. From the U.S. Census Bureau's analysis of the 2007 American Community Survey, in the last thirty years the number of people over the age of five that speak a second language in the home besides English has doubled, and this growth rate is four times the amount of the United State's population growth (U.S. Census Bureau, 2010). Of those who speak another language in the home besides English, 41,938,197 or 75.7% indicated that they also speak English "very well" or "well" (Shin & Kominski, 2010). Future research

and practice will need to adjust to accommodate such a growing population. Specifically looking at the clinical setting, if bilingual children consistently show an advantage in executive functioning, separate norms for scoring their performance may need to be established in order to assess bilingual children accurately. There could be potential cases of an executive functioning weakness in a bilingual child not being apparent to clinicians if monolingual norms are used. Also, research in this area could affect parent decision-making about whether or not to have their child exposed to a bilingual environment. If a clinically-referred child is struggling, there may be discussions about whether a bilingual environment is adding too much complexity to their learning environment. This study may suggest differently in that bilingualism may not present a vulnerability for compromised children (e.g. Paradis, Crago, Genesee, & Rice, 2003), and therefore more research needs to be done in this area to solidify knowledge about whether a bilingual environment hinders a child's learning or gives him/her stronger skills in executive functioning to serve as valuable tools for learning.

The bilingual or multiple language exposed population is a growing population which calls for more research and understanding in this area. Such research will allow for more culturally sensitive and valid service to bilingual children and families who are referred for a neuropsychological evaluation.

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