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REPORT COVER SHEET

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Bilingualism in Children with Autism: Exploring the Impact of Dual Language Learning

Challenges with executive function (EF) skills are commonly found in children with autism[1]. EF refers to skills used to regulate attention and goal-oriented behavior used to engage in complex social and cognitive activities[2]. Bilingualism requires the use of cognitive systems in such a way that the EF abilities of neurotypical bilinguals are advantaged compared to neurotypical monolinguals[3,4]. Given this evidence, it seems possible that bilingualism could promote advantaged EF development for autistic children. If so, bilingualism could act as a cost-effective naturalistic intervention to support development[5], which may reduce challenges in adaptive and social development.

A small handful of existing research on this topic has produced mixed results. Some studies have found that bilingual children with autism experience a reduction in EF difficulties in daily life[5,6,7], whereas other research has failed to consistently find an advantage based on parent and teacher reports[8,9]. Further research is needed to clarify the effect of bilingualism on the EF development of autistic children across a range of bilingual proficiencies and language learning environments (i.e., school or home).

The current study further examines the effect by distinguishing children who are exposed to bilingual language environments early in development from those who are exposed to a second language after the development of a second language (i.e., second language learners). I am guided by the following questions: 1) Can exposure to bilingualism mitigate EF for autistic children, and does this compare to advantages experienced by neurotypical bilingual children compared to neurotypical monolingual children? and 2) Do autistic children exposed to bilingualism experience an advantage in adaptive functioning compared to monolingual autistic children and does this compare to advantages experienced by neurotypical bilingual children compared to neurotypical monolingual children?

Methods

Participant

121 children, aged six to sixteen years of age, participated in the study. Two children were removed from the sample due to incomplete outcomes measures. A further 10 children were removed as they did not meet the inclusion criteria. The final sample included 109 children across 6 study groups: 1) autistic children raised in bilingual environments (AUT-B), 2) autistic children who are second language learners (AUT-LL), 3) autistic children raised in monolingual environments (AUT-M), 4) neurotypical children raised in bilingual environments (NT-B), 5) neurotypical children who are second language learners (NT-LL), and 6) neurotypical children raised in monolingual environments (NT-M). Appendix A outlines the inclusion and exclusion criteria for each study group. Table 1 outlines the demographic information of the sample.

Procedure

Participating children were recruited from across Canada via social media and local autism community organizations. Parents of participating children completed the study questionnaires over the phone. All questionnaires were administered in English. A summary of the results was provided to parents following participation, if desired.

Measures

Social Responsiveness Scale, Second Edition (SRS-2)

The SRS-2 is a standardized measure that identifies the presence of common characteristics within the autism spectrum[10]. The cut-off score was used to confirm a clinical diagnosis of autism within the sample.

Child Language Exposure Questionnaire

The Child Language Exposure Questionnaire[11] was used to capture the child's language background and assess language exposure. The questionnaire consists of questions about the child's current and lifetime language in order to determine the child's language status.

Alberta language and development questionnaire (ALDeQ)

The ALDeQ was developed to assess the presence of language impairment among English language learners[12]. The questionnaire consists of four parts: 1) early milestones, 2) first language abilities, 3) activity preferences, and 4) family history. The ALDeQ will be used to explore the first language development of children in the sample.

Comprehensive Executive Function Inventory (CEFI)

The CEFI is a parent-report questionnaire of executive functioning in children 5 to 18 years of age[13]. The CEFI measures global EF as well as multiple sub-components of EF.

Behaviour Rating Inventory of Executive Function, Second Edition (BRIEF-2)

The BRIEF-2 is a parent report rating scale of EF skills used during daily life at home[14]. The questionnaire measures the extent to which a child regulates and guides their behavior in everyday environments.

Vineland Adaptive Behaviour Scales, Third Edition (Vineland-3)

The Vineland-3 is a measure of adaptive behavior and daily functioning in individuals from birth to 90 years of age that was used to assess adaptive functioning[15]. The parent-report form assesses functioning across 3 domains: 1) communication, 2) daily living skills, and 3) socialization.

Analytic Approach

I performed statistical analyses using SPSS version 27 for Mac. To address the research questions, I conducted a between groups multivariate analysis of variance (MANOVA) to examine the group differences on the outcome variables. Prior to

conducting the MANOVA, a factor analysis of the two parent-report EF ratings scales (BRIEF-2 and CEFI) was completed to create an overall EF score for each participant. Alpha was set at 0.05. The assumption of statistical tests was checked prior to analysis. The Vineland-3 data was transformed as it violated the normality assumption.

Results

Table 2 shows the mean total scores and standard deviations for the parent-report EF and adaptive skills rating scales. Table 3 shows correlations between the outcome measures. In an effort to reduce issues with multicollinearity, a factor analysis was completed with the scales from the BRIEF-2 and CEFI with a single EF factor being extracted based on scree plot examination (see Figure 1).

A two-way MANOVA of the EF factor and overall adaptive score, with maternal education as a covariate, revealed a main effect of diagnostic group, $F(2, 97) = 114.36$, $p = <0.001$. Post hoc t-tests revealed significant difference between the autistic and neurotypical groups on EF skills ($t(104) = -13.78$, $p = <0.001$) and adaptive functioning ($t(103) = 12.37$, $p = <0.001$). The main effect of language status was not significant, $F(4, 196) = 0.64$, $p = 0.64$. The interaction between diagnostic status and language status was also not significant, $F(4, 196) = 0.58$, $p = 0.68$.

Discussion

The current study investigated the bilingual advantage on EF skills and adaptive functioning for children with autism and children with typical development. In an effort to understand the influence of the timing of bilingual exposure, the current study distinguished between children who are exposed to two or more language simultaneously prior to the age three years from those who learn a second language after the development of their first language is established, which is believed to occur after the age of three years[16]. The present findings do not provide support for a bilingual advantage among autistic children nor neurotypical children. Among children with autism exposure to a bilingual environment did not confer any advantage or disadvantage to the development of EF skills and adaptive functioning. Bilingual status also did not contribute to differences in EF skills and adaptive functioning among neurotypical children. Our results replicate previous findings that indicate children with autism experience greater challenges in EF skills and adaptive functioning compared to their peers with neurotypical development.

The findings of the current study have important implications for the recommendations provided to bilingual families with children with autism. Parents have reported that they have been advised against exposing their child to a bilingual environment[17,18] due to the fear that bilingualism might overwhelm the developmental capacity of children with autism[19, 20]. Parents themselves also indicate concerns that exposure to a bilingual environment may lead to confusion for their child[21]. However, the results of this study contribute to a growing body of evidence that demonstrate that exposure to a bilingual environment does not create developmental differences for bilingual children with autism compared to monolingual children with autism.

Tables

Table 1. Demographics by group.

Variable	AUT-B (N=21)	AUT-LL (N=16)	AUT-M (N=17)	TD-B (N=22)	TD-LL (N=16)	TD-M (N=17)	Test Statistic
Mean age in months (Standard Deviation)	118.95 (36.01)	115.94 (35.23)	131.76 (26.58)	106.19 (37.34)	114.25 (38.37)	98.35 (35.83)	F (5, 102) = 1.84, *p* = 0.11
Gender (% male)	71.4	68.8	94.1	40.9	62.5	52.9	X^2(5, n=109) = 0.35, *p* =0.02, phi = 0.35
Born Outside Canada (%)	14.3	12.5	11.8	18.2	0	0	*p* = 0.28 (Fisher- Freeman- Halton Exact Test)
Maternal education (% university degree)	95.2	75	47.1	63.6	93.8	76.5	*p* = 0.005 (Fisher- Freeman- Halton Exact Test)
>30 Words (%)	90.5	93.3	94.1	100	100	100	*p* = 0.46 (Fisher- Freeman- Halton Exact Test)
First Words (% >25 months)	33.3	12.5	0	4.5	0	0	*p* = <0.001 (Fisher- Freeman- Halton Exact Test)
Speaking L1 (% Limited)	23.8	20.0	11.8	0	0	0	*p* = <0.001 (Fisher- Freeman- Halton Exact Test)
Understanding L1 (% Limited)	14.3	6.7	11.8	0	0	0	*p* = 0.01 (Fisher- Freeman- Halton Exact Test)
Mean ALDeQ Score (Standard Deviation)	0.52 (0.19)	0.67 (0.17)	0.64 (0.19)	0.85 (0.08)	0.87 (0.06)	0.91 (0.05)	F (5, 102) = 23.51, *p* = <0.001

Table 2. Descriptive Statistics for each measure across study groups.

	AUT-B			AUT-LL			AUT-M			TD-B			TB-LL			TD-M		
	N	*M*	*SD*	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
SRS-2	21	75.71	8.72	16	74.13	10.44	17	75.59	7.58	22	45.82	5.09	16	44.31	3.34	17	45.65	4.41
BRIEF-2 GEC	21	71.95	4.75	16	68.38	10.88	17	71.24	8.53	22	50.68	7.82	16	49.94	6.14	17	47.88	7.41
CEFI Total	20	83.60	9.59	16	85.25	9.53	16	82.62	10.14	21	107.24	12.70	16	107.56	9.08	17	108.18	13.48
Vineland-3	20	79.10	15.01	16	84.50	14.50	16	74.87	14.36	20	109.25	8.42	16	108.19	10.50	17	109.06	7.74

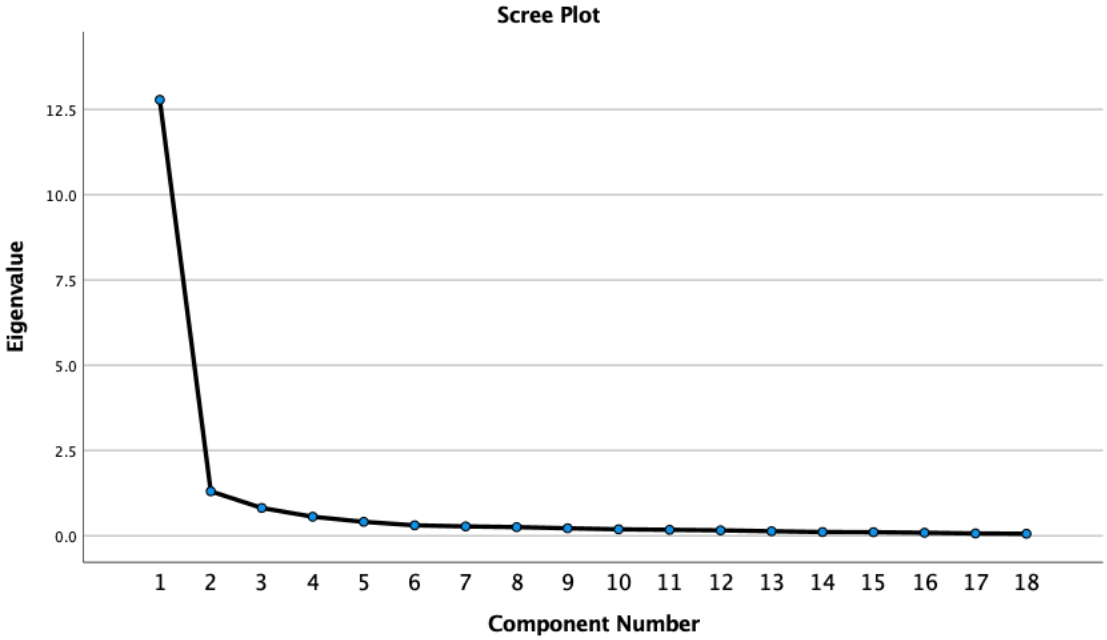
Table 3. Correlation among outcome measures.

	BRIEF-2 GEC	CEFI Total
BRIEF-2 GEC	-	
CEFI Total	-0.89**	-
Vineland-3	-0.72**	0.78**

** Correlation is significant at the 0.01 level

Figures

Figure 1. Scree plot of principal component analysis for executive function scales.



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Appendix

Appendix A. Inclusion and Exclusion Criteria for Study Groups

To be included in bilingual groups, children need to have:

1. Exposure to two or more languages on a regular basis prior to the age of 3 years
2. Current or average lifetime exposure to the second language greater than 20%
3. At least one parent who can speak in English

To be included in the language learning groups, children need to have:

1. Exposure to two or more languages on a regular basis after age of 3 years
2. Current or history of average lifetime exposure after first exposure to the second language greater than 20%
3. Less than 20% average exposure to a second language prior to regular exposure
4. At least one parent who can speak in English

To be included in the functional monolingual groups, children need to have:

1. Current or history of exposure to a second language less than 20%, regardless of age
2. At least one parent who can speak in English

To be included in the autism groups, children need to have/be:

1. Between the age of 6 and 16 years of age
2. Clinical diagnosis of autism given by a pediatrician, psychiatrist or psychologist
3. Confirmation of autism diagnosis with Social Responsiveness Scale, Second Edition

To be included in the neurotypical groups, children need to have/be:

1. Between the age of 6 and 16 years of age
2. No prior diagnoses of neurodevelopmental disorders or language disorders
3. Absence of autism characteristics on Social Responsiveness Scale, Second Edition