Bilingual Children with High Functioning Autism Spectrum Disorder: Evidence from Oral Narratives and Non-verbal Executive Function Tasks

Eleni Baldimtsi, Eleni Peristeri, Ianthi Maria Tsimpli, and Ageliki Nicolopoulou

1. Introduction

Bilingualism is an exponentially increasing condition in today’s world population due to mass immigration and globalization. Today, more than half of the world’s children are raised bilingual (cf. Marian & Shook, 2012). Previous research has shown that individuals raised in bilingual environments enjoy linguistic and cognitive advantages.

More specifically, acquiring a second language has been reported to confer advantages on children’s verbal and non-verbal cognitive abilities. Regarding verbal abilities, bilingual children often outperform monolinguals in areas like perspective-taking, metalinguistic awareness, i.e. the ability to reflect upon and manipulate the structural features of language, and narrative production (Altman, Armon-Lotem, Fichman, & Walters, 2016; Garcia-Frazier, 2013; Greenberg, Bellana, & Bialystok, 2013; Tsimpli, Peristeri, Andreou, 2016; Tunmer & Herriman, 1984). Moreover many studies yield compelling evidence for a bilingual advantage on non-verbal executive control. Tasks assessing inhibition, monitoring, set-shifting and working memory report that bilinguals perform better than monolinguals (Bialystok & Senman, 2004; Hilchey & Klein, 2011; Morales, Calvo, & Bialystok, 2013; Okanda, Moriguchi, & Itakura, 2010).

Children with autism spectrum disorders (ASD) exhibit a unique language phenotype and a unique cognitive profile. In verbal abilities, autism research indicates impairments in areas like pragmatics, semantics, morphosyntax and language comprehension (Boucher, 2012; Kelley, 2011). In contrast, evidence on non-verbal abilities and in particular executive functions (EFs), show that individuals with ASD encounter difficulties in areas like inhibition, flexibility, planning and short-term memory (see Eigsti, 2011 for a review).

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While there has been considerable research showing the beneficial impact of bilingualism on typically-developing (TD) children’s language development and non-verbal EFs, other studies failed to replicate the same findings (e.g. Hilchey & Klein, 2011). To date, the studies that have explored bilingualism in atypical populations have only focused on children with Specific Language Impairment (SLI) (Altman et al., 2016; Tsimpli et al., 2016). To the best of our knowledge, no study exists that examines the impact of bilingualism on the verbal and the non-verbal abilities of children with ASD.

2. The Present Study

The first goal of this study is to characterize the unique aspects of verbal abilities in bilingual children with High Functioning Autism (HFA), focusing on their narratives. More specifically, we aim to evaluate children’s narrative performance in terms of how well they organize past story events in order to build a coherent story (the macrostructural level), as well as how their words and sentences come together in order to build a cohesive story (the microstructural level) (Hughes, McGillivray & Schmidek, 1997). We suspected that bilingualism may lead to enhanced narrative performance especially in the macrostructural domain. Therefore, we predicted that bilingual children with HFA would be better in narrative production than their monolingual peers.

The second goal was to investigate children’s non-verbal EFs with special attention paid to their visual skills when attending to global and local information as well as their updating abilities. Given the accumulating evidence supporting the claim for a positive effect of bilingualism on executive control processes we predicted that bilingual children with HFA would perform better than monolinguals with HFA.

2.1. Research Questions and Hypotheses

Question 1

Does bilingualism compensate for typical difficulties children with HFA face in the verbal domain and narrative performance, in particular?

Hypothesis 1

We expected bilingual children with HFA to show superior performance relative to monolingual children with HFA and partial ‘normalization’ in the degree to which the former group’s narrative performance would be similar to their TD bilingual peers in terms of macrostructural properties but not in terms of narratives’ microstructural properties

Question 2

Does bilingualism compensate for typical patterns of performance in HFA with regard to children’s non-verbal attention and updating abilities?

Hypothesis 2a

We expected bilingual children with HFA to exhibit a less detail-oriented pattern of performance than their monolingual peers with HFA in the visual
attention task, which would manifest in higher accuracy or/and faster responses in the global (vs. local) trials of the task.

Hypothesis 2b

Similarly, we expected bilingual children with HFA to exhibit superior performance than their monolingual peers with HFA in the updating task; such performance would be reflected in the former’s group higher accuracy scores or/and faster speed of responding than monolingual children with HFA.

3. Method

3.1. Participants

A total of 16 male children divided into 4 groups participated in this study: 6 monolingual Greek-speaking children with HFA (HFA-Mono; mean age: 9;8 (SD: 1.2), age range: 7;7 – 11;5); 6 bilingual children with HFA (HFA-Bi; mean age: 9;8 (SD: 1.2), age range: 7;7 – 11;6); 6 TD monolingual Greek-speaking children (TD-Mono; mean age: 9;8 yrs (SD: 1.2); age range: 7;7 – 11;6); and 6 TD bilingual children (TD-Bi; mean age: 9;7 yrs. (SD: 1.3), age range: 7;3 – 11;6). The children were matched across groups for chronological age. There were no significant differences across groups in full scale IQ, $F (3, 23) = 1.850, p = .171$; Greek version of the Weschler Intelligence Scale for Children, Georgas, Paraskevopoulos, Bezevegis & Giannitsas, 2003) as well as in verbal, $F (3, 23) = 2.545, p = .09$, and performance IQ, $F (3, 23) = 1.191, p = .338$ (see Table 1).

Table 1. Number of Children, Mean Verbal IQ, Mean Performance IQ, and Mean Full Scale IQ by Group

<table>
<thead>
<tr>
<th>Group</th>
<th>Verbal IQ M (SD) &amp; $M$ range</th>
<th>Performance IQ M (SD) range</th>
<th>Full Scale IQ M (SD) range</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD-Mono</td>
<td>119 (17.3) 100-149</td>
<td>123 (13.7) 109-143</td>
<td>122 (13.2) 108-142</td>
</tr>
<tr>
<td>(N = 6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TD-Bi</td>
<td>112 (20.3) 86-134</td>
<td>111 (15.6) 90-131</td>
<td>112 (18.5) 89-133</td>
</tr>
<tr>
<td>(N = 6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFA-Mono</td>
<td>99 (14.5) 82-119</td>
<td>110 (18.7) 92-142</td>
<td>105 (18.9) 85-135</td>
</tr>
<tr>
<td>(N = 6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFA-Bi</td>
<td>97 (13.8) 76-112</td>
<td>109 (9.9) 102-127</td>
<td>103 (10.9) 88-117</td>
</tr>
<tr>
<td>(N = 6)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The TD children were selected so that they had normal hearing, no speech, emotional, or behaviour problems, as well as no observed neurological, speech and language deficits. All TD bilingual children were equally exposed to Greek (L2) from birth, and they all had Albanian as their first language (L1). Formal written consent was obtained from the children’s parents prior to participation in the study.

Children with HFA from both groups met criteria for ASD based on expert clinical judgment of the child’s social-adaptive functioning conducted by a child psychiatrist, which was confirmed by the Autism Diagnostic Interview-Revised (Lord, Rutter, & LeCouteur, 1994). According to parental questionnaires and language unit teachers’ reports, there was no delay observed in the children’s early language milestones. The mother tongues of the bilingual children with HFA varied, two of them being Albanian-, one English-, one Russian-, one Ukranian- and one Arabic-speaking. In order to be included in the study, children with HFA had to obtain full-scale IQ scores above 70.

3.2. General Procedure

All four groups of children completed three tasks in a single session in the following order: a narrative task and two non-verbal EF tasks, namely, a visual attention Global-Local task and a two-back updating task. Children were tested at school or at their home.

3.3. Experimental Tasks
3.3.1. Narrative Production Task

*Materials.* Children’s narratives were elicited by using the Edmonton Narrative Norms Instrument (ENNI; Schneider, Dubé, & Hayward, 2005) which has been designed to elicit language data from children aged 4 to 9 through story telling. The story used for the elicitation of narratives (telling) in the present study was the 3-main character Giraffe/Elephant story from Set A which consists of eight pictures and two complete episodes. The pictures for the story were placed in a binder with two pictures appearing on each page.

*Procedure.* Children were individually tested in a quiet room. Before administering the story telling task, the examiner explained to the child that she was unfamiliar with the story and that the child had to be explicit enough when telling the story to allow the examiner to fully understand it. The examiner first went through all the pages so that the child could preview the story, after which the examiner turned the pages again as the child was telling the story. Story telling was recorded using a digital voice recorder.

*Coding and scoring of narratives.* The stories were transcribed verbatim by the first two authors. The transcripts was scored following the guidelines of the Multilingual Assessment Instrument for Narratives tool (Gagarina et al., 2012), which has been adapted into Greek and piloted in Greek-speaking monolingual
and bilingual children (Tsimpili et al., 2016). Both microstructural and macrostructural properties of children’s narratives were coded.

With respect to microstructure the following scores were calculated: (1) *lexical diversity* (number of content word types divided by the total number of content word tokens); (2) *language complexity* (number of coordinate & subordinate sentences divided by the total number of simple and complex sentences); and (2) *syntactic complexity* (number of subordinate sentences divided by the total number of complex sentences).

With respect to macrostructure the following scores were calculated: (1) *story structure complexity* (the number and structure of episodes in the story) (Story Grammar Model; Stein & Glenn, 1979; Gagarina et al., 2012), (2) *diversity in the use of Internal State Terms* (ISTs); the specific category was split into two subcategories, namely, the “plus” and the “minus” Theory of Mind (ToM) ISTs which were calculated by dividing each subcategory by the total number of main clauses (as in Tsimpili et al., 2016), and (3) *referential ambiguity*, i.e. the use of ambiguous pronouns to maintain reference in a narrative; a referential ambiguity index was calculated by diving the number of ambiguous overt and null pronouns in syntactic subject position and clitics in object position by the total number of pronouns produced in each child’s narrative.

3.3.2. Executive Function Tasks
3.3.2.1. Visual Attention Global-Local Task

*Materials.* The visual attention task was modeled after Navon (1977). Stimuli consisted of big (global) shapes of circles, Xs, triangles and squares made up of smaller (local) shapes (i.e. small shapes inside much larger ones). The shapes were designed with the AutoCAD 2012 software and they had perfect analogy (the scale from global to local was 1:10).

*Procedure.* The task consisted of two blocks (the Global and the Local one). Each child was asked to indicate either the global shape or the local shapes that the global figure was made of, and press the appropriate number key. Apart from the level of attention modulated by focusing at the global or local shape, congruency between global and local shapes within each trial was also manipulated.

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1. The first category includes lexical items that conveyed emotion, like sad, happy or scared, as well as cognitive states referring to characters’ thought, desires and beliefs like think, desire or want, and it was characterized as ToM-related ISTs [+ToM-related]. On the other hand, linguistic items like say, call, shout, perceptual items, like feel, hear, smell, and physiological items, like thirsty, hungry, tired were characterized as non-ToM-related ISTs, since they did not give an insight into story characters’ beliefs, thoughts and emotions.
The task was run with E-prime software in a self-paced manner (Schneider, Eschman, & Zuccolotto, 2012). Each child first pressed the space bar upon which a shape appeared at the center of a white screen. The stimulus remained visible until a response was made, unless the time granted for responding elapsed (3000 msecs after the stimulus display’s onset).

Each block consisted of 48 trials which were evenly divided into congruent and incongruent trials. The order of the stimuli presentation in each block was randomized across children. To avoid any response bias effect, half of the children in each group were administered the ‘Global-first’ version and the rest the ‘Local-first’ version of the task. Prior to the beginning of each block, children viewed instructions on the screen that indicated which level they had to attend to (global or local). Instructions were followed by a 16-item practice session. Reaction times (RTs) and accuracy were recorded.

3.3.2.2. Updating Two-Back Task

Materials. In the updating two-back task children saw a sequence of digits (2, 5, 7, 8) on the computer screen. The task contained a total of 20 to-be-responded to (target) digits and 60 trials on the whole.

Procedure. Children had to remember if the digit they saw on the screen was the same as the one presented two positions back in the sequence, and in case it was, to press a pre-specified key (‘J’) with their index finger. No responses were required for non-target digits. Children were familiarized with the task with a practice session of 20 trials. Each trial consisted of a black, 12mm-long digit that was presented for 500 msecs, followed by a blank page that lasted 2500 msecs, after which the next digit stimulus was presented. An accuracy score of the number of correct hits minus the number of false hits was calculated for each child. RT data from correct hits only were analysed.

4. Results
4.1. Narrative Production Task

Table 2 provides descriptive statistics for both microstructure (lexical diversity, language and syntactic complexity) and macrostructure measures (story structure complexity, ±ToM-related ISTs, and referential ambiguity). To compare group performances for each of these microstructural and macrostructural measures, one-way analyses of variance (ANOVAs) were conducted. Controlling for children’s intelligence scores was not possible since neither verbal IQ, performance IQ, or general intelligence IQ were significantly correlated with any of the dependent microstructural and macrostructural measures.
Table 2. Group Mean Scores (and SDs) on Microstructure and Macrostructure Variables

<table>
<thead>
<tr>
<th>Group</th>
<th>Lexical Diversity</th>
<th>Language Complexity</th>
<th>Syntactic Complexity</th>
<th>Story Structure Complexity</th>
<th>[-ToM]- ISTs</th>
<th>Referential Ambiguity</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD-Mono (N = 6)</td>
<td>0.61 (0.11)</td>
<td>0.78 (0.15)</td>
<td>0.48 (0.32)</td>
<td>7.8 (1.4)</td>
<td>0.08 (0.09)</td>
<td>0.18 (0.09)</td>
</tr>
<tr>
<td>TD-Bi (N = 6)</td>
<td>0.61 (0.05)</td>
<td>0.85 (0.12)</td>
<td>0.60 (0.22)</td>
<td>9.3 (0.9)</td>
<td>0.16 (0.12)</td>
<td>0.25 (0.27)</td>
</tr>
<tr>
<td>HFA-Mono (N = 6)</td>
<td>0.68 (0.03)</td>
<td>0.54 (0.18)</td>
<td>0.61 (0.21)</td>
<td>7.5 (1.26)</td>
<td>0.25 (0.07)</td>
<td>0.10 (0.12)</td>
</tr>
<tr>
<td>HFA-Bi (N = 6)</td>
<td>0.66 (0.06)</td>
<td>0.65 (0.13)</td>
<td>0.57 (0.24)</td>
<td>9.5 (1.03)</td>
<td>0.15 (0.07)</td>
<td>0.15 (0.12)</td>
</tr>
</tbody>
</table>

Narrative production. Regarding narrative production the results confirmed our hypothesis. In particular, microstructural measures revealed a significant group effect for the language complexity measure, $F (3, 23) = 5.079$, $p = .009$, which stems from the fact that monolingual children with HFA had significantly lower language complexity scores ($M = 0.54$) than the TD monolingual children ($M = 0.78$) $p = .05$. There were no other significant between-group differences in language complexity scores. No significant group differences were found for either lexical diversity, $F (3, 23) = 1.224$, $p = .327$, or syntactic complexity, $F (3, 23) = 0.321$, $p = .810$.

Results on macrostructure revealed significant group effects for story structure complexity ($F (3, 23) = 4.103$, $p = .012$), [-ToM-related] IST use ($F (3, 23) = 3.544$, $p = .033$) and referential ambiguity ($F (3, 23) = 4.287$, $p = .010$).

The group effect in story structure complexity is due to monolingual HFA children’s significantly lower scores ($M = 7.5$) compared to their bilingual peers with HFA ($M = 9.5$) $p = .036$. The differences between TD monolingual and TD bilingual children ($p = .168$), monolingual children with and without HFA ($p = .966$) and bilingual children with and without HFA ($p = .995$) were not significant.

The group effect in [-ToM-related] IST use, stems from monolingual HFA children’s significantly more [-ToM-related] ISTs in their narrative productions ($M = 0.25$) relative to their TD monolingual peers ($M = 0.08$) $p = .020$. The differences between monolingual and bilingual children with HFA ($p = .256$), TD monolingual and bilingual children ($p = .500$), and bilingual children with
and without HFA \((p = 1.0)\) were not significant. There was no significant group effect observed for [+ToM-related] IST use, \(F(3, 23) = .806, p = .505\).

With respect to the group effect in referential ambiguity, this was attributed to monolingual HFA children’s marginally higher use of referentially ambiguous forms (\(M=.50\)) than bilingual children with HFA (\(M=.29\)) \(p = .06\). The differences between TD monolingual and TD bilingual children (\(p = .548\)), monolingual children with and without HFA (\(p = .08\)) and bilingual children with and without HFA (\(p = .570\)) were not significant.

**Summary of Narrative Task:** Overall, the results support our general hypothesis that bilingual children with HFA would be better able to narrate in terms of macrostructure (i.e. story structure complexity, IST use, and use of the appropriate referential forms) than their monolingual HFA peers. However, this advantage was not evident in the microstructural level of the produced stories (i.e. neither in lexical diversity nor in syntax).

4.2. Executive Function Tasks

4.2.1. Visual Attention Global-Local Task

The results from the non-verbal cognitive tasks partially confirmed our hypothesis. Table 3 below presents the mean reaction times (in msecs) and accuracy rates per group for all four experimental conditions (global congruent, global incongruent, local congruent, local incongruent).

<table>
<thead>
<tr>
<th>Group</th>
<th>Reaction Times(M, SD)</th>
<th>Accuracy (Mean %, SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Global Level</td>
<td>Local Level</td>
</tr>
<tr>
<td></td>
<td>Congruent</td>
<td>Incongruent</td>
</tr>
<tr>
<td>TD-Mono</td>
<td>1372</td>
<td>1680</td>
</tr>
<tr>
<td>((N = 6))</td>
<td>((483.8))</td>
<td>((568.3))</td>
</tr>
<tr>
<td>TD-Bi</td>
<td>1582</td>
<td>1993</td>
</tr>
<tr>
<td>((N = 6))</td>
<td>((648.9))</td>
<td>((602.7))</td>
</tr>
<tr>
<td>HFA-Mono</td>
<td>1918</td>
<td>2552</td>
</tr>
<tr>
<td>((N = 6))</td>
<td>((734.8))</td>
<td>((714.4))</td>
</tr>
<tr>
<td>HFA-Bi</td>
<td>1262</td>
<td>1539</td>
</tr>
<tr>
<td>((N = 6))</td>
<td>((397.3))</td>
<td>((708.9))</td>
</tr>
<tr>
<td>Accuracy</td>
<td>97.2</td>
<td>94.5</td>
</tr>
<tr>
<td>((N = 6))</td>
<td>((0.03))</td>
<td>((0.07))</td>
</tr>
<tr>
<td>TD-Bi</td>
<td>92.2</td>
<td>89.0</td>
</tr>
<tr>
<td>((N = 6))</td>
<td>((0.03))</td>
<td>((0.08))</td>
</tr>
<tr>
<td>HFA-Mono</td>
<td>82.6</td>
<td>78.8</td>
</tr>
<tr>
<td>((N = 6))</td>
<td>((0.19))</td>
<td>((0.17))</td>
</tr>
<tr>
<td>HFA-Bi</td>
<td>91.8</td>
<td>81.2</td>
</tr>
<tr>
<td>((N = 6))</td>
<td>((0.11))</td>
<td>((0.13))</td>
</tr>
</tbody>
</table>
We begin with the analyses of the RTs. A mixed-design ANOVA was conducted with Group (i.e. TD-Mono, TD-Bi, HF-Mono, HFA-Bi) as between-subjects factor, and Attention (global, local) and Congruency (congruent, incongruent) as within-subject factors.

There was a significant main effect of Attention ($F(1, 20) = 4.477, p = .04$) and Congruency, $F(1, 20) = 13.031, p = .002$, which stems from global (1737 msecs) and congruent trials (1704 msecs) being responded to significantly faster than local (1979 msecs) and incongruent trials (2012 msecs), respectively. There was also a significant two-way interaction between Group and Attention ($F(1, 20) = 3.465, p = .05$). We next conducted separate repeated measures ANOVAs for each group to search for the source of this interaction. The analyses showed that both TD groups exhibited significant Attention and Congruency effects, with global and congruent trials being responded to significantly faster than local and incongruent trials, respectively (Attention effect: $F(1, 5) = 7.947, p = .037$ for TD monolingual children, and $F(1, 5) = 7.282, p = .043$ for TD bilingual children; Congruency effect: $F(1, 5) = 18.072, p = .008$ for TD monolingual children, and $F(1, 5) = 5.641, p = .05$ for TD bilingual children). Bilingual children with HFA have also exhibited a significant Attention effect ($F(1, 5) = 5.348, p = .05$) but a non-significant Congruency effect ($F(1, 5) = 3.725, p = .111$). The attention effect stemmed from their significantly faster responses in the global (1400 msecs) trials of the task compared to the local trials (1581 msecs). The monolingual group with HFA did not exhibit either a significant Attention or a significant Congruency effect ($F(1, 5) = 3.674, p = .111$ for Attention, and $F(1, 5) = 1.609, p = .260$ for Congruency). No significant Attention by Congruency interactions were observed for either group. Crucially, between-group comparisons on RTs for each type of trials revealed non-significant group differences for either condition ($F(3, 23) = 1.211, p = .331$ for global congruent trials, $F(3, 23) = 1.313, p = .298$ for global incongruent trials, $F(3, 23) = 1.043, p = .395$ for local congruent trials, and $F(3, 23) = .652, p = .591$ for local incongruent trials).

With respect to the accuracy measure, the same mixed-design ANOVA analysis revealed a significant Congruency effect ($F(1, 20) = 10.000, p = .005$), and a significant two-way interaction between Group and Attention ($F(1, 20) = 5.022, p = .009$). Separate repeated measures ANOVAs for each group were subsequently conducted to identify the source of the significant two-way interaction. We report on our analysis for the TD groups first. While the TD bilingual group has exhibited significant Attention and Congruency effects ($F(1, 5) = 44.651, p = .001$, and $F(1, 5) = 7.788, p = .038$, respectively) in the expected direction, i.e. global and congruent trials were responded to considerably more accurately than local and incongruent trials, respectively), the TD monolingual group did not exhibit significant effects for either variable ($F(1, 5) = 3.674, p = .111$ for Attention, and $F(1, 5) = 1.609, p = .260$ for Congruency). On the other hand, monolingual children with HFA have exhibited a significant Attention effect stemming from local trials being responded to significantly more accurately than global trials ($F(1, 5) = 5.665, p = .05$); the
Congruency effect was not found to be significant (\( F(1, 5) = 4.154, p = .10 \)). There were no significant effects for the bilingual group with HFA. Finally, between-group comparisons on accuracy for each type of trial revealed a significant group difference for local incongruent trials only (\( F(3, 23) = 1.689, p = .201 \) for global congruent trials, \( F(3, 23) = 1.331, p = .292 \) for global incongruent trials, \( F(3, 23) = 1.653, p = .209 \) for local congruent trials, and \( F(3, 23) = 3.358, p = .039 \) for local incongruent trials). Subsequent post-hoc tests showed that the significant group effect for the local incongruent trials stemmed from TD bilingual children’s considerably lower accuracy scores relative to their bilingual peers with HFA (\( p = .05 \)).

4.2.2. Updating Two-Back Task

These results confirmed our hypothesis. Table 4 presents the accuracy rates (i.e. composite raw score of the number of correct hits minus the number of false hits) per group, as well as the mean RTs on correct responses only.

<table>
<thead>
<tr>
<th>Group</th>
<th>Accuracy M (SD)</th>
<th>RTs M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD-Mono (N = 6)</td>
<td>15.0 (0.08)</td>
<td>375 (30.1)</td>
</tr>
<tr>
<td>TD-Bi (N = 6)</td>
<td>9.1 (0.08)</td>
<td>389 (99.6)</td>
</tr>
<tr>
<td>HFA-Mono (N = 6)</td>
<td>12.5 (0.13)</td>
<td>394 (53.4)</td>
</tr>
<tr>
<td>HFA-Bi (N = 6)</td>
<td>27.1 (0.04)</td>
<td>348 (34.4)</td>
</tr>
</tbody>
</table>

A one-way ANOVA analysis was first conducted with Accuracy as the dependent variable. The analysis revealed a significant group effect (\( F(3, 23) = 4.462, p = .015 \)). Subsequent post hoc tests showed that the effect mainly stemmed from bilingual HFA children scoring significantly higher than both TD bilingual (\( p = .013 \)) and monolingual children with HFA (\( p = .05 \)). The same analysis conducted on the RTs of the groups’ target responses did not reveal a significant group effect (\( F(3, 23) = .684, p = .572 \)).

Summary of Executive Function Tasks: Overall, the results support our general hypothesis that bilingual children with HFA would perform in a less detail-oriented manner than their monolingual peers with HFA and also that they would exhibit better updating abilities than their monolingual peers with HFA.
5. Discussion and Conclusions

The present study investigated whether bilingualism may alleviate deficits caused by autism at the verbal and the non-verbal domain by investigating monolingual and bilingual HFA children’s performance in narratives and non-verbal EF tasks. While many studies have examined the impact of bilingualism on the narrative performance and the EFs of TD bilingual children and monolingual children with ASD, to the best of our knowledge no study exists that has investigated the effect of bilingualism in children with HFA. We examined the impact of bilingualism in HFA on story-telling, as well as on two non-verbal EF skills, namely visual attention and updating. We hypothesized that on story-telling bilingual children with HFA would perform better than their monolingual peers with HFA in macrostructure, i.e. the ability to integrate constituent parts of a story to make a meaningful whole, and that the bilingual group with HFA would be less impaired than monolinguals with HFA in visual attention and updating.

The results of children’s narrative performance revealed no significant differences between the two groups with HFA in microstructure. In fact, bilingual children with HFA were not found to differ from their HFA monolingual peers in either measure, indicating that the microstructure of the HFA children’s narrative performance was not affected by bilingualism. On the other hand, monolingual children with HFA showed poorer performance than the TD monolingual group in language complexity but not in lexical diversity and syntactic complexity where no significant differences were observed among the groups. The specific difference between the two monolingual groups in language complexity implies that monolingual children with HFA did not link events using coordination or/and subordination to the same extent as their TD monolingual peers, but rather recounted the story by event lists instantiated by simple sentences. Difficulty in organizing narratives by establishing spatial and temporal relations among events that uniquely define story episodes have been reported in prior studies of narratives in ASD (Boucher, 2012; Diehl, Bennetto & Young, 2006). The fact that there was no group difference in syntactic complexity suggests that the narrative performance of both groups with HFA was not negatively influenced by the need to link events using a rather high-demanding form of syntactic organization like subordination.

On the other hand, bilingualism proved to compensate for HFA children’s performance in the macrostructure of narratives, specifically, in story structure complexity and reference use. With respect to story structure complexity, monolingual children with HFA performed lower than their bilingual peers with HFA in meaningfully encoding items and events, and relationships between them. With regard to the use of reference, monolingual children with HFA tended to use ambiguous forms significantly more often than bilingual children with HFA; in fact, half of the monolingual group’s referential expressions were ambiguous with respect to their antecedent(s) (see Table 2). The fact that pronouns tended to be used by the monolingual group with HFA when more
informative nominal expressions would be more appropriate implies difficulty with identifying the referents’ saliency while structuring discourse as well as with quantifying the information available to the listener. Inappropriate reference use has been well documented in prior studies on children with ASD (e.g. Arnold, Bennetto, & Diehl, 2009). The finding that bilingual children with HFA outperformed their monolingual peers with HFA on both story structure complexity and referential ambiguity measures indicates that bilingualism helped them integrate the isolated story events into a holistic percept and increased their sensitivity to the listener’s perspective of the story, respectively. Bilingualism was not found to have an impact on HFA children’s use of ISTs in their narratives.

The analysis of children’s performance in the non-verbal visual attention task reveals significant differences between the two groups with HFA. More specifically, bilingual children with HFA exhibited a less detail-focused processing style compared to their monolingual peers with HFA which was mainly evident in their significantly faster RTs on the global (vs. local) trials of the task in contrast to the monolingual group with HFA whose RTs remained undifferentiated with respect to the level they should focus on while doing the task. In fact, the bilingual HFA group’s RT performance was found to align with the performance of the TD bilingual group which has also shown a global processing advantage in its RTs, i.e. global trials were responded to considerably faster than local trials. The specific results indicate that bilingual children with HFA were closer to bilingual TDs’ performance in the degree to which they managed to focus on the global stimuli of the task.

Finally, the two-back task has also revealed significant differences between the two groups with HFA. More specifically, bilingual HFA children’s accuracy score was significantly higher relative to their monolingual peers with HFA as well the TD bilingual children. Interestingly, apart from obtaining the highest score on correct hits, bilingual children with HFA were the group exhibiting the lowest rates of false hits (5 false hits; collapsing across subjects) relative to the rest of the groups (12, 30 and 36 false hits for TD monolingual, TD bilingual and monolingual HFA children, respectively). This finding indicates an enhanced ability to voluntarily inhibit prepotent responses (Aron, 2007) or/and increased working memory resources that allowed bilingual children with HFA to rapidly absorb and remember large amounts of digit sequences.

Overall, bilingualism appeared to contribute differently to HFA children’s performance in the narrative task with its impact being evident mainly on the macrostructural level of narrative representation. More specifically, bilingualism was found to mostly contribute to better story structure complexity and avoidance of use of referentially ambiguous forms, both being macrostructural properties. With respect to children’s performance in the non-verbal tasks, bilingualism was found to mitigate children’s over-sensitivity to local aspects of the stimuli that autism is expected to bring. Specifically, bilingualism contributed to a decrease of the ‘detail-oriented’ focus style that characterized the performance of the monolingual children with HFA in the
global-local task, while it also enhanced HFA children’s updating and working memory abilities in the two-back task.

References


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