Applied Psycholinguistics (2022), 1–19
doi:10.1017/S0142716422000108

CAMBRIDGE
UNIVERSITY PRESS

ORIGINAL ARTICLE

Associations between bilingualism and attention-deficit hyperactivity disorder (ADHD)-related behavior in a community sample of primary school children

Curtis J. M. Sharma*, Napoleon Katsos and Jenny L. Gibson

University of Cambridge, Cambridge, UK
*Corresponding author. Email: cjms2@cam.ac.uk

(Received 13 January 2021; revised 29 March 2022; accepted 7 April 2022)

Abstract

It has been found that bilinguals and children from minority backgrounds lag behind monolinguals or those in the majority culture, with respect to prevalence, assessment, and treatment for attention-deficit/hyperactivity disorder (ADHD). This suggests that bilingualism might be yet another factor giving rise to variability in ADHD. Using regression methods, we analyzed parent reports for 394 primary school-age children on background and language experience, ADHD-related behavior, and structural language skill in English to explore whether bilingualism is associated with levels of ADHD-related behavior. Bilingualism as a category was associated with slightly lower levels of ADHD-related behavior. Bilingualism as a continuous measure showed a trend of being associated with lower levels, but this did not quite reach significance. Structural language skill in English was the main predictor of levels of ADHD-related behavior; higher skill predicting lower levels. More investigation is required to confirm whether these effects occur across different populations, to understand which, if any, aspects of bilingualism give rise to variability, and if need be, to address these as far as possible.

Key words: ADHD; ADHD-related behavior; bilingualism; structural language skill

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is the most common neurobehavioral condition reported in childhood, with prevalence at around 5.29–7.1% of the under-18 population worldwide (G. Polanczyk et al., 2007; G. V. Polanczyk et al., 2014; Willcutt, 2012). ADHD is a clinical umbrella term for a set of behaviors, namely inattentiveness, hyperactivity, and impulsivity, which may or may not occur together (Diagnostic and Statistical Manual of Mental Disorders, fifth edition, (American Psychiatric Association, 2013)). The inattentive child may be easily distracted by nonrelevant stimuli, indulge in excessive daydreaming, or may have difficulty in organizing tasks and activities. The hyperactive/impulsive child may show excessive motor activity being unable to sit still for any period of time, or may act rashly, making decisions without foresight (W. Roberts et al., 2015). The affected population is recognized as being clinically heterogeneous (Faraone & Biederman, 1998, p. 951). ADHD is a disorder that results from higher-than-normal levels of symptoms that are typical of all children, and for which different individuals may be affected to different degrees in the domains of inattentiveness and hyperactivity/impulsivity (Roberts et al., 2015, p. 62).

The etiology of ADHD has been described as involving the interaction of genetics, neurobiology, and adverse environmental conditions, including psychosocial adversity resulting from family conflict and exposure to parental psychopathology (Biederman et al., 1995; Faraone & Biederman, 1998; Fuller-Thomson & Lewis, 2015; Neale et al., 2010; Russell et al., 2015). It is often described as a categorical condition, but it may be better understood as dimensional rather than categorical. Given the important role of environment in the etiology of ADHD, this heterogeneity is not surprising. In addition to environmental risk factors, variability in ADHD is known to be associated with age and sex. ADHD-related behavior tends to decrease as the individual matures (Faraone et al., 2006; Ramtekkar et al., 2010). Studies have also found that males generally show a slightly higher level of ADHD-related behavior than females, although it is still debated as to why this may be the case (Gershon, 2002; Owens et al., 2015, p. 243; Ramtekkar et al., 2010).

Another aspect of life experience that might add to variability is language experience, that is, whether the individual speaks, or is exposed to, more than one language, as opposed to a single one. Studies have reported that children and adolescents from minority ethnic backgrounds tend to lag behind those from non-minority ethnic backgrounds, with respect to both prevalence and treatment of ADHD (Eiraldi et al., 2006; Haack et al., 2016; Robert. E. Roberts et al., 2006; Rothe, 2005; Stevens et al., 2004). In the UK, it has been reported that children from Indian, Pakistani, Bangladeshi, and Chinese backgrounds showed near-significantly ($p = .06$) lower ADHD prevalence than White or African-Caribbean children (Ford et al., 2003). Finally, it has been reported that in the EU, bilingual children are less likely to be referred for assessment, or diagnosed with, ADHD (Clark, 2012). Among other things, proficiency in the majority language of reporting caregivers, cultural influences on caregiver expectation of development (Rothe, 2005; Stevens et al., 2004), or knowledge about ADHD (Eiraldi et al., 2006) have been suggested to play a part in these differences.

Added to these varied factors associated with bilingualism in society is the possibility that bilingualism may influence ADHD at the cognitive level. This is because as with ADHD, bilingualism has been said to be associated with changes in attention. Studies have repeatedly found that bilinguals, regardless of the language currently in use, cannot "switch off" their other language(s), but must constantly monitor all languages during both comprehension and production (Bobb et al., 2013; Colomé, 2001; Costa et al., 2008; Costa & Santesteban, 2004; Kroll & Bialystok, 2013). The question has therefore been raised as to whether, for individuals with ADHD, practising bilingualism has any effect on attentional difficulties, positive or negative, or none at all.

Observed differences in prevalence, assessment, and treatment of ADHD among minority and bilingual children as compared to others should motivate further investigation to determine what aspects or consequences of these experiences might underlie those differences. Such research could be beneficial both to the individuals and communities involved, society as a whole, as well as our understanding of whether and how language experience might impact the cognitive profile of the child with ADHD. However, there is a dearth of research in this area. To date, there have been only three published studies investigating the interaction of bilingualism and ADHD, all focusing on the interactive effects of bilingualism and ADHD as categories on performance in tasks purporting to target cognitive abilities associated with attentional control – so-called executive functions. Two of these involved young adult populations (Bialystok et al., 2016; Mor et al., 2015).The third study looked at a general child population (8–11 years old). It investigated bilingualism both as a category and as a continuous measure and ADHD rating as a continuous measure (Sorge et al., 2017).

The concept of executive function is a complex and controversial one. There are difficulties related to its definition, if and how many components are involved, and whether these components can be distinguished and reliably targeted and measured (Castellanos et al., 2006; Miyake et al., 2000; Paap & Greenberg, 2013; Rabbitt, 2005; Toplak et al., 2013; Zelazo & Müller, 2002). Further, it has been established that deficits in executive function are neither necessary nor sufficient in explaining all instances of ADHD (Coghill et al., 2014; Nigg et al., 2005; Willcutt et al., 2005)

The present study makes no use of the concept of executive function or executive function measures for these reasons. We propose instead that investigating interactions between bilingualism and ADHD-related behavior at the self-regulatory level could provide its own valuable insights into variability in ADHD associated with bilingualism, while avoiding complexity and controversy linked to executive function. These three studies are, of course, nevertheless very important for the field and have been instrumental in developing the concepts and approaches for the present study. One finding in Bialystok et al. (2016), though not the main one, was particularly relevant; that bilinguals as a group scored lower (better) on two measures of hyperactivity/impulsivity, significantly on one (Bialystok et al., 2016, p. 7). We likewise compare ratings of ADHD-related behavior between monolinguals and bilinguals as groups, but for a community sample of primary school children; the first study to do so. Following the approach taken by Sorge et al. (2017), we treat bilingualism both as a category and a continuous measure. In a further step, we also look for possible associations with particular aspects of bilingual experience, for example, oral and literacy competency, and frequency of bilingual communication between caregiver and child, and age of onset of bilingualism.

In addition, we have included structural language skill in English in our analyses. It is well established that children with ADHD have a higher prevalence of difficulties with language (Camarata & Gibson, 1999; Geurts & Embrechts, 2008; Hawkins et al., 2016; Sciberras et al., 2014). Therefore, it is important to account for effects from language ability when investigating ADHD-related behavior. We selected a measure of structural language skill as opposed to a pragmatic measure, as structural language skill provides a good measure of language ability without duplicating behavior intrinsic to diagnosis of ADHD, as would likely be the case with a pragmatic language use measure, for example, interrupting others or having difficulty with turn-taking. Our research questions are as follows, in a community ascertained sample of children:

(1) Are there differences in ADHD-related behavior between bilinguals and monolinguals when bilingualism and monolingualism are defined categorically?
(2) Does bilingualism explain variance in ADHD-related behavior when bilingualism is conceptualized as a continuous measure?
(3) Are there particular aspects of bilingualism that explain variance in ADHD-related behavior when bilingualism is conceptualized as a continuous, multimodal experience?

RQ 1 was addressed by looking at the whole sample, while RQs 2 and 3 were addressed by looking within the bilingual sample. For RQ1, it was predicted that there would be an effect for bilingualism as a category on levels of ADHD-related behavior, such that those children reported as bilinguals would show lower levels of ADHD-related behavior than monolinguals. For RQ 2, it was predicted that "more" bilingualism would be associated with lower levels of ADHD-related behavior. For RQ 3, it was predicted that oral and literacy proficiency, more regular usage, and earlier age of onset of bilingualism would be inversely proportional to level of ADHD-related behavior. We further predicted that higher structural language skill in English would be associated with lower levels of ADHD-related behavior.

Method

Ethics approval for the reported study was granted by the University of Cambridge Psychology Research Ethics Committee (Reference number: PRE.2016.049). Caregivers gave their informed, written consent on behalf of their children. The data that support the findings of this study are available in Reshare.

Instruments

Data were collected via three questionnaires. All questionnaires were available in English only.

Language and family background questionnaire (LBQ)

The language and family background questionnaire (LBQ), based on the Alberta Language Environment Questionnaire (Paradis, 2011), is composed of 5 sections. Section 1 gathers general information about the child, for example, date of birth, place of birth, date of arrival in the UK if born in another country. The final question in this section asks caregivers to name each language (including English) their child can speak and/or understand, listing all even if the child displayed little ability in any of these languages. If any language in addition to English was noted, sections 2 and 3 were completed so as to provide more detail about bilingualism. In section 2, parents

https://doi.org/10.1017/S0142716422000108 Published online by Cambridge University Press

noted the age of onset of bilingualism for their child and rated their child's speaking, understanding, reading, and writing competences in all their languages. Section 3 gathered information about the frequency of use of English versus non-English languages between the child and caregivers. A Likert scale of 1 – 5 was used to indicate the child's speaking, understanding, reading, and writing proficiency in all their languages including English (1 = *not competent* (some, but little ability); 5 = *very competent* (fluent, very comfortable, high ability). For language use between child and caregiver (0 – 1), any score over 0.5 indicates prevalence of English, while any score of less than 0.5 indicates prevalence of non-English languages. Section 4 asks questions about family circumstances in order to establish socioeconomic status (SES). These are based on a standardized composite of the Family Affluence Scale (Currie et al., 2008) and the average level of education attained by the child's caregivers (1 = *primary school*; 2 = *secondary school*; 3 – *bachelor's degree*; 4 = *master's degree*; 5 = *doctoral degree*). Finally, section 5 asks questions about any cognitive-related, intellectual, or academic difficulties experienced by the child or members of their immediate family.

Social skills improvement system-rating scales (SSIS-RS) parent form

The social skills improvement system-rating scales (SSIS-RS) (Gresham & Elliott, 2008) was used to gather information on ADHD-related behavior. It is a questionnaire designed to assist in screening of children and young people in education, who may be suspected of having social skills deficits and who exhibit problem behaviors to such an extent that it affects their daily lives. The questions are divided into two domains: Social Skills and Problem Behaviors. It is a multirater system, whereby parents, teachers, and students, if old enough, provide ratings on observance of positive behaviors (social skills), for example, communication, cooperation, assertion, responsibility, and self-control, and negative (problem) behaviors, for example, externalizing, ADHD-related behavior (as "hyperactivity/inattention"), and autism spectrum. Teacher and parent raters provide frequency-based ratings on a four-point Likert scale (0 = *never*; 1 = *sometimes*; 2 = *often*; 3 = *almost always*). The SSIS-RS was normed on a sample United States population of 4,700 children from across 36 states. Reliabilities of the Social Skills and Problem Behavior scales are high with alpha coefficients in the mid to upper .90s, and median subscale reliabilities in the high, mid, and low .80s for teacher, parent, and student forms, respectively. Only the parent form was utilized in the present study. Reliability of the ADHD-subscale at standardization is good at $\alpha = 84$ (boys), $\alpha = .85$ (girls), and $\alpha = .85$ (combined) for ages 5–12 years.

The SSIS-RS ADHD subscale was developed with reference to symptoms outlined in the disruptive behaviors disorder (DBD) Rating Scale in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) (American Psychiatric Association, 2000). It is made up of 2 statements related to inattentiveness, 4 to hyperactivity/impulsivity, and 1 to oppositional defiant disorder (ODD). Scores are summed and a child could be rated between 0 and 21: 0 being "below average," 1 and 9, "average," and 10 and 21, "above average," for the age group of 5–12 years. The inclusion of a statement related to ODD in the SSIS-RS ADHD subscale is based on the established high degree of comorbidity observed between ADHD and ODD (Burns et al., 2001; Jensen et al., 2001; Thorell & Wåhlstedt, 2006). Behavior related to ODD might therefore be an indication of difficulties related to ADHD. Our study was designed with the RDoC framework (National Institute of Mental Health, 2009, 2018) in mind, which suggests examining the full range of variation from normal to abnormal. This approach has been specifically suggested for the study of EF and ADHD (Cuthbert, 2014). The SSIS-RS, being an instrument of high sensitivity, seemed well suited to capture this range.

Children's communication checklist, version 2 (CCC2)

Language skills in English were measured using the Structural Language Composite subscale of the CCC2 (Bishop, 2003). Only the English-language version of this questionnaire was used, and parents were instructed to rate their children's ability for English only. The CCC2 is used to screen children who are likely to have a language impairment and to identify pragmatic language use deficits in children with communication problems. It is an observer-rater questionnaire designed to be completed by the child's parent, carer, or someone else who has regular contact with the child and has had the opportunity to observe their communicative behavior frequently over a long period of time. The CCC2 is made up of 70 statements grouped into 10 subscales of 7 items each, which refer to positive and negative communication behaviors; the rater indicates on a 4-point Likert scale (0–3), how often these are observed in the child. Reliability at standardization for all scales is at least acceptable at $\alpha = .65$ (Bishop, 2003, p. 35). The 10 subscales are *speech, syntax, semantics, coherence, inappropriate initiation* [of communication], *stereotyped language, use of context, nonverbal communication, social relations, and interests*. The subscales assess different skills relevant to communication, for example, the *speech* subscale asks whether the child "leaves off beginnings or ends of words"; the *syntax* scale asks whether he or she "produces utterances that sound babyish because they are just 2 or 3 words long"; the *semantics* scale asks whether he or she "mixes up words of similar meaning"; and the *coherence* scale asks whether he or she "gets the sequence of events muddled up when telling a story or describing an event." Summing up the scores from these 4 subscales yields the structural language composite (SLC).

Procedure

Invitations to participate in the study were sent to 333 state-funded primary schools across Cambridgeshire and London in the UK. Fourteen schools accepted the invitation. Thirteen of these schools fell under a local authority in which the percentage of children with English as an additional language (EAL) ranged from 12.6 to 25%, and the remaining one, 37.6–50% (Strand et al., 2015). Totally, 2800 packs comprising an information letter, an opt-in consent form, and the three questionnaires, were distributed to children to take home. Where siblings took part, an individual pack was completed and returned for each child.

Preliminary analysis and analysis plan

Reliabilities for the SSIS-RS and CCC2 within the study sample were found to be good at $\alpha = .82$ and excellent at $\alpha = .96$, respectively.

Bilingual proficiencies were measured using the non-English language in which the child was reported to be the strongest (language A). Other aspects of bilingualism included were: level of bilingual use with caregivers, measured as the proportion of time a non-English language was used between caregiver and child, and age of onset of language A. Three sets of multiple regressions were run. Following Sorge et al. (2017), bilingualism was treated as a category in analysis of the whole sample, while for the bilingual sample, bilingual ability was treated as a continuous variable. This was measured as a composite of oral proficiency in language A, literacy proficiency language A, and bilingual use with caregivers. In the first set of regressions, we looked for effects of language status ("0" = bilingual, "1" = monolingual) as a category on ADHD-related behavior. In the second set of regressions, analysis within the bilingual group was carried out to see whether bilingual ability was associated with levels of ADHD-related behavior. In the third set, we looked to see if we could identify a specific aspect of bilingual experience associated with ADHD-related behavior.

Regressions were initially run including predictor and target variables and all other variables that correlated significantly with levels of ADHD-related behavior. If bilingualism, bilingual ability, or any aspect of bilingualism proved to be a significant predictor of ADHD-related behavior, then a reverse step would be taken to determine the value of variance due to these predictors.

Results

Participants

Totally, 401 packs were returned. Of these, seven contained incorrect or incomplete information and data from these were not used, leaving a sample population of 394 children (213 Girls; 181 Boys) included in the study. Age range across the whole sample was (5;1-11;8, $M = 8.17$; $SD = 1.63$). In total, 331 (84%) participants were born in the United Kingdom, with another 19 (5%) born in the United States of America, Australia, and Ireland, and the remaining 44 (11%) born in Spain, France, Portugal, Italy, Belgium, Austria, Germany, Norway, Sweden, Finland, Latvia, Poland, Bulgaria, Romania, Greece, Israel, Jordan, Hong Kong, China, India, Singapore, Japan, Thailand, Fiji, Nigeria, Uganda, and Brazil. There were 39 non-English languages used in the homes, and school instruction for all children was in English. Among those children in the group "bilinguals," the majority spoke one language in addition to English ($n = 119$); some, an additional two languages ($n = 35$); others, an additional three ($n = 8$), and finally others, an additional four languages ($n = 2$). All 394 children, including those with reported cognitive-related diagnoses and difficulties were included in the analysis. Among monolinguals, the following cognitive-related diagnoses and possible diagnoses were reported: ADHD ($n = 1$), ADHD, and SPD (Sensory Processing Disorder, $n = 1$); autism ($n = 1$), ADOS (Autism Diagnostic Observation Scehdule) and suspected ADHD ($n = 1$), autistic traits and diagnosed with Social Communication Disorder ($n = 1$); dyslexia

https://doi.org/10.1017/S0142716422000108 Published online by Cambridge University Press

Table 1. Descriptive statistics, whole sample

Variable	Group	*n*	Mean	*SD*	Pairwise comparison
Chronological Age (years)	Bilinguals	164 (f = 92; m = 72)	8;1	1;7	W = 17277 (*p* = .155)
	Monolinguals	230 (f = 121; m = 109)	8;4	1;7	
Family Afluence Score	Bilinguals	164	6.79	1.49	W = 18160 (*p* = .56)
	Monolinguals	230	6.92	1.39	
Level of Education Caregiver 1	Bilinguals	164	3.42	1.19	W = 24030 (*p* < .001)
	Monolinguals	229	2.83	1.16	
Level of Education Caregiver 2	Bilinguals	152	3.28	1.16	W = 18839 (*p* = .01)
	Monolinguals	215	2.93	1.3	
Socioeconomic Status (*z*-score, composite*)	Bilinguals	164	0.11	0.8	W = 22610 (*p* < .001)
	Monolinguals	230	−0.10	0.7	
Structural Language Composite	Bilinguals	160	40.25	11.02	W = 17169 (*p* = .529)
	Monolinguals	223	41.19	10.33	
ADHD-related Behavior	Bilinguals	164	4.82	3.26	W = 18032 (*p* = .456)
	Monolinguals	230	5.27	3.87	

f = females, m = males; all distributions were non-normal; therefore, nonparametric *t*-tests (Wilcoxon rank-sum test) were run. SES was a composite of education levels of caregiver 1, caregiver 2 (where available), and the Family Afluence Scale (Currie et al., 2008).

(*n* = 8); Global Developmental Delay (*n* = 1); microdeletion syndrome (*n* = 1). Among bilinguals, the following cognitive-related diagnoses and possible diagnoses were reported: suspected ADHD (*n* = 1), suspected of both having ADHD and being on autism spectrum (*n* = 1), suspected of having both ADHD and dyslexia (*n* = 1); dyslexia (*n* = 1); Global Developmental Delay (*n* = 1).

Descriptive statistics and bilingualism as a category

Table 1 reports descriptive statistics for the whole sample. There were 230 monolinguals (121 girls; 109 boys) and 164 bilinguals (92 girls; 72 boys). There was no difference in average age between monolinguals and bilinguals. The mean age for monolinguals was 8 years; 4 months (*SD* = 1;7, with a range of 5;1 – 11;8. For biliinguals, the mean age was 8;1 (*SD* = 1;7, with a range of 5;3 – 11;4). SES was well distributed in the sample, with a skew to the right of the distribution (range: 0 – 14: *M* = 10: *MED* = 10. Monolinguals scored slightly higher on the Family Affluence scale, though this was not significant. Bilinguals on the other hand scored significantly higher on education level obtained by caregiver 1 (W = 24030, *p* < .001) and caregiver 2 (W = 18839, *p* = .01). Overall bilinguals scored significantly higher on SES measures than monolinguals (W = 22610, *p* < .001). There was no significant difference in structural language composite (SLC) score.

Table 2. Correlations (Spearman's rho) between ADHD-related behavior levels, background characteristics, and SLC for whole sample

	Age	Sex	SES	SLC (English)
Sex	0.04			
SES	−0.02	0.10		
SLC (English)	0.01	−0.12	0.11	
ADHD-related Behavior	**−0.10***	**0.16*****	0.02	**−0.37*****

***Correlation significant at the 0.001 level, **correlation significant at the 0.01 level, *correlation significant at the 0.05 level. *Note*: female coded as "0," male coded as "1," SLC = Structural Language Composite subscale (CCC2).

Finally, for ADHD-related behavior, the mean for both bilingulas (4.82) and monolinguals (5.27) fell within the "normal" range according to the SSIS-RS ADHD subscale(1 – 9). There was also no significant difference in level of ADHD-related behavior between bilinguals and monolinguals; the median for both language groups was the same, although the mean score in the monolingual group was slightly higher. This comparison, however, did not take into consideration factors like age, SES, sex, or language skills.

Correlational analysis (Spearman's rho) of background variables with ADHD-related behavior level for the whole sample is shown in Table 2. Age correlated negatively and significantly with ADHD-related behavior level ($r_s = -0.10$, $p < .05$). That is, caregivers of younger children reported higher levels of ADHD-related behavior than caregivers of older children. There was also significant correlation for sex and ADHD-related behavior ($r_s = 0.17$, $p < .001$) with males showing significantly higher levels. Structural language skills (measured via SLC) correlated negatively and significantly with ADHD-related behavior level ($r_s = -0.37$, $p = 0.000$), meaning the higher the level of language skill, the lower the level of behavior. Although there was a small effect for SES, this was not significant. Therefore, only age, sex, and SLC, were carried forward to the next stage of analysis as independent variables in a regression along with the test variable, language status, and ADHD-related behavior level as the dependent variable.

These results are shown in Table 3. This model was significant (F (5, 376) = 21.84, $p < .001$), with an R^2 of 0.225 (adjusted $R^2 = 0.215$). Age and sex emerged as significant predictors of ADHD-related behavior, with younger children and males showing higher levels. Language status also emerged as a significant predictor of ADHD-related behavior, with bilingualism as a category being associated with slightly lower levels, accounting for a small but significant proportion of the variance ($R^2 = 0.011$, $p = .0347$), based on both unadjusted and adjusted R^2. Structural language skill in English, however, measured through the SLC, accounted for the greatest variation ($R^2 = 0.17$, $p < .001$), with better language skill predicting lower ADHD-related behavior.

Bilingualism as a continuous measure

Descriptive statistics for the bilingual group are reported in Table 4, and the distribution of oral and literacy proficiency skills is shown in Figure 1, along with

https://doi.org/10.1017/S0142716422000108 Published online by Cambridge University Press

Table 3. Results of multiple linear regression predicting ADHD-related behavior based on age, sex, SES, structural language use, and language status

ADHD-related behavior $n = 382$	ΔR^2	B	$SE\ B$	β	p
Step 1	0.216 (adjusted 0.208)				<.001
	Constant	12.392	1.041		< .001
	Age	−0.001	0.000	−0.115	= .015
	Sex	0.772	0.331	0.108	= .02
	SES	0.024	0.337	−0.003	= .944
	SLC	−0.141	0.016	−0.422	< .001
Step 2	0.225 (adjusted 0.215)				
	Constant	12.184	1.041		< .001
	Age	−0.001	0.112	−0.119	= .001
	Sex	0.746	0.108	0.104	= .024
	SES	0.040	−0.003	0.006	= .905
	SLC	−0.143	0.015	−0.427	< .001
	Language Status[1]	0.698	0.329	0.970	= .035

[1]Bilingual coded as “0,” monolingual coded as “1”.

language use with caregivers and age of onset of language A. Oral and literacy proficiencies were calculated by totalling scores for speaking and understanding and reading and writing, respectively. Language use with caregivers was given as the proportion of time English is used between child and caregivers. Bilingual ability was a composite of oral proficiency, literacy proficiency, and bilingual use with caregivers. For this latter score, language use with caregivers was inverted and multiplied by 10 to match oral and literacy proficiency scores. Bilingual ability is the mean of these three scores.

Figure 1 shows that for language A, around 27% of bilingual children were very highly proficient, orally, with around 49% scoring over 7.5 and another 26% score below 5. For literacy proficiency, it is almost the opposite, with 29% scoring less than 2.5, and 54% scoring less than 5; only 17% score higher than 7.5. Conversation between child and caregiver is heavily weighted towards English, with around 75% of parents reporting conversations in English at least half the time, and 48% over three quarters of the time. It is clear also from Table 4 that the bilinguals in this study are dominant in English. Oral proficiency in language A is around two-thirds of that in English, while literacy in language A is half of what it is in English. Further, there is wide variety in the frequency of use of non-English languages. English is used 70% of the time between child and caregivers. While the mean for bilingual ability is close to the median at 4.90, it is clear that there is a wide range (1.33 – 9.33). Aside from the peaks at the higher end of oral proficiency and the lower end of literacy proficiency, there is not much variation across these measures, as was reflected in their negative kurtosis values (Table 4). Correlations (Spearman's rho)

https://doi.org/10.1017/S0142716422000108 Published online by Cambridge University Press

Table 4. Descriptive statistics bilinguals

Variable	n	Mean	*SD*	Range	Kurtosis
Speaking English (scale of 1 – 5)	164	4.78	.54	1 – 5	4.48
Understanding English (scale of 1 – 5)	164	4.86	.38	1 – 5	6.85
Reading English (scale of 1 – 5)	164	4.62	0.76	1 – 5	3.94
Writing English (scale of 1 – 5)	164	4.18	0.93	1 – 5	0.26
Speaking Language A (scale of 1 – 5)	164	3.12	1.55	1 – 5	−1.53
Understanding Language A (scale of 1 – 5)	164	3.54	1.51	1 – 5	−1.26
Reading Language A (scale of 1 – 5)	160	2.51	1.38	1 – 5	−1.02
Writing Language A (scale of 1 – 5)	159	2.15	1.22	1 – 5	−0.37
Language Use with Caregivers*	160	0.70	0.23	0.20 – 1.0	−0.85
Age of Onset Language A (in years)	161	0.98	2.24	1.14 – 1.48	3.07
Bilingual Ability**	155	4.90	0.18	1.33 – 9.33	−1.28

*Proportion of time English is used between child and caregiver; Language A is the non-English language in which the child has the highest oral and literacy proficiencies; **composite of oral proficiency, literacy proficiency, and bilingual use with caregivers. For this score, language use with caregivers was inverted and multiplied by 10 to match oral and literacy scales. Bilingual ability is the mean of these three scores.

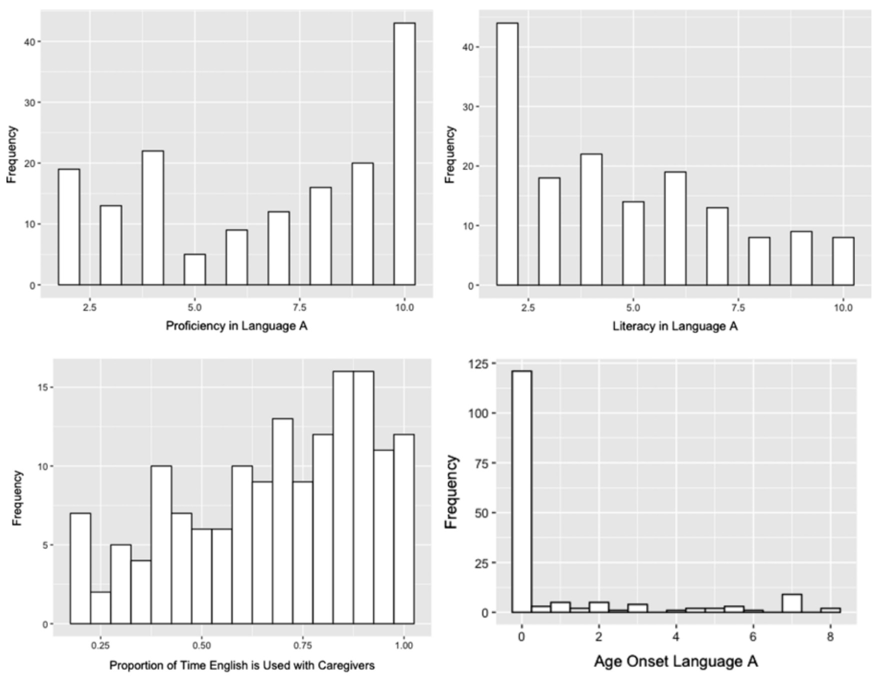

Figure 1. Graphs showing the variation of levels of aspects of bilingualism in the study.
Proficiency is the sum of speaking and understanding scores in language A; literacy is the sum of reading and writing scores in Language A; age of onset of language A is measured in years.

Table 5. Correlations (Spearman's rho) between ADHD-related behavior levels, SLC, and language experience for bilinguals

	Age	Sex	SES	Age Onset A	Oral Prof. Eng.	Oral Prof. A	Lit. Prof Eng.	Lit Prof A	Bilingual Use CGs	Bilingual Ability	SLC (English)
Sex	−0.05										
SES	−0.01	0.03									
Age Onset A	**0.03***	−0.11	−0.09								
Oral Prof. Eng.	0.19	−0.06	0.14	0.02							
Oral Prof A	**0.03***	−0.07	0.06	**−0.43***	−0.15						
Lit. Prof Eng.	**0.60***	−0.08	0.10	**0.27***	0.52***	−0.03					
Lit. Prof. A	**0.28***	−0.08	0.14	**−0.35***	0.06	**0.65***	**0.25**				
Bilingual Use CGs	−0.07	0.09	−0.09	**−0.26**	−0.28	0.77	−0.15	**0.44***			
Bilingual Ability	0.09	−0.09	0.05	−0.41	−0–14	**0.94***	0.03	**0.81***	0.84		
SLC (English)	−0.01	−0.17	0.13	0.02	**0.39***	0.08	**0.31***	**0.20***	0.09	0.08	
ADHD-related behavior	−0.09	0.09	−0.04	−0.02	−0.14	**−0.16***	**−0.23***	**−0.18***	0.09	**−0.17***	**−0.43***

***Correlation significant at the 0.00 level, *correlation significant at the 0.05 level; female coded as "0," male coded as "1"; A = language A; Oral Prof = speaking and understanding proficiency; Lit Prof = reading and writing proficiency; Lang. use CGs = language use with caregivers; SLC = Structural Language Composite subscale CCC2.

Table 6. Results of multiple regression predicting ADHD-related behavior in the bilingual sample on bilingual ability (composite score of oral and literacy proficiencies in language A and proportion of use of non-English languages with caregivers)

Bilingual Group $n = 160$	ΔR^2	B	$SE\ B$	β	p
	0.170 (adjusted 0.163)				<.001
Step 1	Constant	9.400	0.864		< .001
	SLC	−0.117	0.021	−0.4101	< .001
Step 2 $n = 152$	0.201 (adjusted 0.190)				
	Constant	10.523	0.994		< .001
	SLC	−0.121	0.021	−0.423	< .001
	Bilingual Ability	−0.178	0.105	−0.125	=.091

between all variables for the bilingual sample are shown in Table 5. Oral proficiency in language A correlated negatively and significantly with ADHD-related behavior level ($r_s = -0.16$, $p = .029$), as did literacy in English ($r_s = -0.23$, $p = .014$) and literacy in language A (rs $= -0.18$, $p = .015$). SLC again correlated negatively and significantly with ADHD-related behavior level ($r_s = -0.43$, $p = 0.000$).

The results for the second multiple regression, looking at bilingual ability, SLC, and ADHD-related behavior, are shown in Table 6. This regression was significant (F (2, 149) = 18.73, $p < .001$), with an R^2 of 0.20 (adjusted $R^2 = 0.19$). SLC significantly predicted lower levels of ADHD-related behavior, accounting for 17% of variance ($p < .001$). While bilingual ability was also associated with lower levels of ADHD-related behavior (3% of variance), this did not reach significance at $p = .091$.

Results from the third regression (Table 7) with literacy in English, oral and literacy proficiency in language A, and SLC as independent variables, and level of ADHD-related behavior as the dependent variable in the bilingual sample, are shown in Table 7. A significant regression equation was found (F (4, 155) = 9.47, $p < .001$), with an R^2 of 0.20 (adjusted $R^2 = 0.18$). SLC alone emerged as a predictor of ADHD-related behavior level accounting for a significant proportion of variance ($R^2 = 0.13$).

Discussion

The aim of the present study was to investigate relations between ADHD-related behavior and bilingualism as a category (RQ1), bilingualism as a continuous measure (RQ2), and certain aspects of bilingualism, also as continuous measures (RQ3). For RQ1, there was a significant association between bilingualism and slightly lower levels of ADHD-related behavior. For RQ2, there was an association between bilingual ability and lower levels of ADHD-related behavior, but this fell short of reaching statistical significance. For RQ3, no associations were found between individual aspects of bilingualism (oral and literacy proficiencies, frequency of bilingual use with caregivers, or age of onset of bilingualism) and ADHD-related behavior. We are inclined to accept these results, as our findings for other variables known

https://doi.org/10.1017/S0142716422000108 Published online by Cambridge University Press

Table 7. Results of multiple regression predicting ADHD-related behavior in the bilingual group on sex, structural language composite score, literacy proficiency in English, and oral and literacy proficiency in language A

Bilingual Group $n = 156$	ΔR^2	*B*	*SE B*	β	*p*
	0.21 (adjusted 0.19)				<.001
Constant		12.164	1.525		< .001
SLC		−0.113	0.022	−0.393	< .001
Literacy English		−0.232	0.159	−0.117	= .147
Oral Proficiency Language A		−0.148	0.106	−0.138	= .165
Literacy Language A		−0.033	0.130	−0.026	= .802

to significantly predict levels of ADHD-related behavior, age, sex, and SES are in line with the established literature. In addition, language difficulties including lower structural language skill have been consistently found in children with ADHD, as discussed in the introduction.

Our main conclusion is that bilingualism as a category may be associated with lower levels of ADHD-related behavior, answering RQ1. While the effect was small, that does not necessarily argue against this conclusion. Outcomes for all covariables known to be associated with ADHD-related behavior were as expected, and our sample size is one of the largest of its kind. The results suggest something similar yet different to the observation in Bialystok et al. (2016), in which young bilingual adults with ADHD scored lower (better) than monolinguals with ADHD on two ADHD rating scales used; significantly on one of them. These are, of course, only two studies. There needs to be more research, probably a meta-analysis of studies looking at child, adolescent, and adult ADHD, to examine how difficulties in different domains abate or exacerbate with age.

This conclusion raises more questions than it answers, complicating discussion around minority and bilingual children in relation to ADHD prevalence, detection, and treatment. As we have controlled for age, sex, SES, and structural language skill, we are left to explain this result either through cultural differences, which might have affected reporting of behaviors, or some change to the cognitive profile due to bilingual experience, or a cumulative effect of both. From a cultural standpoint, bilinguals made up 42% of the sample, which suggests parents in these bilingual families are almost as willing as parents in monolingual English families, to volunteer information about their child's behavior. Of the whole sample, 89% of children were born in majority English-speaking countries (84% in the UK), and the remaining 11% born in 27 different countries: mostly from Western Europe, followed by Eastern Europe, South America, Africa, Asia, and Oceania. Further, 39 languages were spoken overall. The bilinguals involved therefore represent a wide variety of cultures, making it less likely that reporting of behavior among bilinguals was dominated by cultural bias or carer expectation of development. High SES and high educational attainment among bilingual caregivers in the study may also speak against ignorance of ADHD.

Taking this line leaves us with the explanation that in some way bilingual experience changes the cognitive profile of the child exhibiting ADHD-related behavior.

https://doi.org/10.1017/S0142716422000108 Published online by Cambridge University Press

Indeed, this is the hypothesis tested in Mor et al. (2015), Bialystok et al. (2016), and Sorge et al. (2017), although, as noted in the introduction, there are many complexities surrounding executive function conception, definition, and measurement. More research needs to be carried out to arrive at clearer understanding of the cognitive abilities used and affected in ADHD and also in bilingualism. Likewise, larger scale studies using as many dimensions as possible need to be carried out involving bilingual and minority populations, to tease apart cultural factors from cognitive ones.

With reference to RQ2, it was surprising that association between bilingual ability (a continuous measure) and lower levels of ADHD-related behavior did not reach significance. Similarly surprising were the results for aspects of bilingualism (RQ3), where no association was found between any of these and level of ADHD-related behavior. It is possible that this was because bilinguals in our sample were dominant in English. Overall, there might have been not enough variation in the bilingual sample in degree of bilingualism to detect significant association with levels of ADHD-related behavior. It is also possible that our measures of bilingual proficiencies and usage were not sensitive or detailed enough. For language A, we used a 1-5 Likert scale (for each of speaking, understanding, reading, and writing). For usage, we asked only about conversations between caregiver and child and not between the child and any other relative. We also did not ask about clubs, classes, media interaction, etc., in languages other than English, which could have impacted the results. Our scales for oral proficiency and usage were only about communication in general. Perhaps had we used more detailed and sensitive measures, on par with the SLC in English (CCC2), which asked 28 questions covering speech, syntax, semantics, and coherence, we would have obtained a more fine-grained idea of language A, and values for specific aspects of skills in language A more closely related to ADHD-related behavior. It could be proposed that collecting similarly detailed and isolated structural language skill in language A might reveal a similar effect for that language on levels of ADHD-related behavior. However, a second explanation is also available. It might be that the experience of having to use more than one language in and of itself suffices to bring about the effects obtained in this study. That is, there is something categorically different between monolingual and bilingual development not related to level of bilingual experience, but to the binary experience of using more than one language. It was found, for example, that among 4- to 6-year-olds, children regularly exposed to multilingual environments were significantly better at taking the perspective of the other individual than monolingual children; in addition, making significantly less egocentric choices than monolinguals (Fan et al., 2015).

Our result regarding structural language skill is important as it extends findings in the literature regarding associations between language skill and ADHD-related behavior, as cited in the introduction; supporting both that language difficulties may be an indication of attention difficulties and that language difficulties should be considered when devising and implementing intervention strategies. Further, language difficulties and ADHD-related behavior are often discussed in terms of difficulties with pragmatics or discourse. The clear association between structural language skill and levels of ADHD-related behavior at different levels of analysis in the present study provides further evidence that these difficulties extend to structural aspects in language use and is evident even at low levels of ADHD-related behavior.

Aside from those already mentioned, there are other factors to consider when interpreting our results. First, whereas there were children who were at-risk, assessed, or diagnosed with ADHD, these were few. One explanation for this could be the high levels of SES in the sample. While all levels were represented, the mean was at 10 out of a total score of 14. Many studies have reported associations between low SES and ADHD (Rowland et al., 2018; Russell et al., 2015, 2016). Notably, SES for bilinguals was significantly higher than for monolinguals, which suggests our bilingual sample may not be representative of the general population. It might also be that parents of bilingual children were hesitant to take part in the study. Looking back at difficulties reported for participants, there is an imbalance with many more monolingual children reported as having them than bilingual children. Differences in the way children are brought up across different cultures, or fears about possible additional difficulties, might have played a role how behaviors were reported. Finally, while the SSIS-RS, as a sensitive instrument, may have the advantage of detecting all individuals whose behavior relate to ADHD, it may also detect individuals whose behavior might not. Therefore, it cannot be ruled out that some children whose behaviors do not ultimately relate to ADHD have been included in the analysis.

In conclusion, the present study investigated associations between bilingualism and levels of ADHD-related behavior in a community sample of primary school children. It was found that there was a small but significant association between bilingualism as a category and lower levels of ADHD-related behavior. There was also a small effect for bilingualism as a continuous measure; however, this did not quite reach significance. We also found that higher structural language skill was significantly associated with lower levels of ADHD-related behavior both in the whole sample and in the bilingual sample. These results support previous findings that bilingualism does not further burden the child who may exhibit ADHD-related behavior, and that even at low levels of ADHD-related behavior, there are associations with language skills. In addition, the results suggest that investigations at the self-regulatory level could add value to research into ADHD and bilingualism. It adds to the nascent literature in this area, which nevertheless is important for scientific understanding, the individuals involved, and society at large.

Acknowledgments. The authors would like to thank the parents, children, and schools who participated in this study, as well as Draško Kašćelan who contributed by way of data collection. Finally, we would like to thank the reviewers for their constructive feedback during the review process.

The first author of this research is funded by the Economic and Social Research Council (Research Councils United Kingdom) Doctoral Training Partnership (ES/J500033/1), while the other two co-authors would like to thank the Arts and Humanities Research Council (UK) for support through project Multilingualism: Empowering Individuals, Transforming Societies (MEITS, AH/N004671/1).

Conflict of interests. The authors declare none.

References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental health disorders (4th ed., text revision)* (4th ed.). American Psychiatric Association.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM–5)*. American Psychiatric Association.

Bialystok, E., Hawrylewicz, K., Wiseheart, M., & Toplak, M. (2016). Interaction of bilingualism and attention-deficit/hyperactivity disorder in young adults. *Bilingualism: Language and Cognition, FirstView*, 1–14. https://doi.org/10.1017/S1366728915000887

Biederman, J., Milberger, S., Faraone, S. V., Kiely, K., Guite, J., Mick, E., Ablon, J. S., Warburton, R., Reed, E., & Davis, S. G. (1995). Impact of adversity on functioning and comorbidity in children with attention-deficit hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, **34**(11), 1495–1503. https://doi.org/10.1097/00004583-199511000-00017

Bishop, D. (2003). *The children's communication checklist version 2 (CCC-2)*. Psychological Corporation.

Bobb, S. C., Wodniecka, Z., & Kroll, J. F. (2013). What bilinguals tell us about cognitive control: Overview to the special issue. *Journal of Cognitive Psychology*, **25**(5), 493–496. https://doi.org/10.1080/20445911.2013.822724

Burns, G. L., Boe, B., Walsh, J. A., Sommers-Flanagan, R., & Teegarden, L. A. (2001). A confirmatory factor analysis on the DSM-IV ADHD and ODD symptoms: What is the best model for the organization of these symptoms? *Journal of Abnormal Child Psychology*, **29**(4), 339–349. https://doi.org/10.1023/A:1010314030025

Camarata, S. M., & Gibson, T. (1999). Pragmatic language deficits in attention-deficit hyperactivity disorder (ADHD). *Mental Retardation and Developmental Disabilities Research Reviews*, **5**(3), 207–214. https://doi.org/10.1002/(SICI)1098-2779(1999)5:3<207::AID-MRDD7>3.0.CO;2-O

Castellanos, F. X., Sonuga-Barke, E. J. S., Milham, M. P., & Tannock, R. (2006). Characterizing cognition in ADHD: Beyond executive dysfunction. *Trends in Cognitive Sciences*, **10**(3), 117–123. https://doi.org/10.1016/j.tics.2006.01.011

Clark, S. (2012). *Brief overview: The situation of people with ADHD in Europe*. ADHD Europe. http://www.adhdeurope.eu

Coghill, D. R., Hayward, D., Rhodes, S. M., Grimmer, C., & Matthews, K. (2014). A longitudinal examination of neuropsychological and clinical functioning in boys with attention deficit hyperactivity disorder (ADHD): Improvements in executive functioning do not explain clinical improvement. *Psychological Medicine*, **44**(5), 1087–1099. https://doi.org/10.1017/S0033291713001761

Colomé, À. (2001). Lexical activation in bilinguals' speech production: Language-specific or language-independent? *Journal of Memory and Language*, **45**(4), 721–736. https://doi.org/10.1006/jmla.2001.2793

Costa, A., Hernández, M., & Sebastián-Gallés, N. (2008). Bilingualism aids conflict resolution: Evidence from the ANT task. *Cognition*, **106**(1), 59–86. https://doi.org/10.1016/j.cognition.2006.12.013

Costa, A., & Santesteban, M. (2004). Lexical access in bilingual speech production: Evidence from language switching in highly proficient bilinguals and L2 learners. *Journal of Memory and Language*, **50**(4), 491–511. https://doi.org/10.1016/j.jml.2004.02.002

Currie, C., Molcho, M., Boyce, W., Holstein, B., Torsheim, T., & Richter, M. (2008). Researching health inequalities in adolescents: The development of the Health Behaviour in School-Aged Children (HBSC) Family Affluence Scale. *Social Science & Medicine*, **66**(6), 1429–1436. https://doi.org/10.1016/j.socscimed.2007.11.024

Cuthbert, B. N. (2014). The RDoC framework: Facilitating transition from ICD/DSM to dimensional approaches that integrate neuroscience and psychopathology. *World Psychiatry*, **13**(1), 28–35. https://doi.org/10.1002/wps.20087

Eiraldi, R. B., Mazzuca, L. B., Clarke, A. T., & Power, T. J. (2006). Service utilization among ethnic minority children with ADHD: A model of help-seeking behavior. *Administration and Policy in Mental Health and Mental Health Services Research*, **33**(5), 607–622. https://doi.org/10.1007/s10488-006-0063-1

Fan, S. P., Liberman, Z., Keysar, B., & Kinzler, K. D. (2015). The exposure advantage: Early exposure to a multilingual environment promotes effective communication. *Psychological Science*, **26**(7), 1090–1097. https://doi.org/10.1177/0956797615574699

Faraone, S. V., & Biederman, J. (1998). Neurobiology of attention-deficit hyperactivity disorder. *Biological Psychiatry*, **44**(10), 951–958. https://doi.org/10.1016/S0006-3223(98)00240-6

Faraone, S. V., Biederman, J., & Mick, E. (2006). The age-dependent decline of attention deficit hyperactivity disorder: A meta-analysis of follow-up studies. *Psychological Medicine*, **36**(2), 159–165. https://doi.org/10.1017/S003329170500471X

Ford, T., Goodman, R., & Meltzer, H. (2003). The British child and adolescent mental health survey 1999: The prevalence of DSM-IV disorders. *Journal of the American Academy of Child & Adolescent Psychiatry*, **42**(10), 1203–1211. https://doi.org/10.1097/00004583-200310000-00011

Fuller-Thomson, E., & Lewis, D. A. (2015). The relationship between early adversities and attention-deficit/hyperactivity disorder. *Child Abuse & Neglect*, **47**, 94–101. https://doi.org/10.1016/j.chiabu.2015.03.005

Gershon, J. (2002). A meta-analytic review of gender differences in ADHD. *Journal of Attention Disorders*, **5**(3), 143–154. https://doi.org/10.1177/108705470200500302

Geurts, H. M., & Embrechts, M. (2008). Language profiles in ASD, SLI, and ADHD. *Journal of Autism and Developmental Disorders*, **38**(10), 1931–1943. http://dx.doi.org/10.1007/s10803-008-0587-1

Gresham, F., & Elliott, S. N. (2008). *Social skills improvement system rating scales*. Minneapolis, MN: NCS Pearson.

Haack, L. M., Gerdes, A. C., Lawton, K. E., & Schneider, B. W. (2016). Understanding and measuring functional impairment in diverse children with ADHD: Development of the ADHD-FX scale with an at-risk, community sample. *Journal of Attention Disorders*, **20**(6), 487–500. https://doi.org/10.1177/1087054714527791

Hawkins, E., Gathercole, S., Astle, D., & Holmes, J. (2016). Language problems and ADHD symptoms: How specific are the links? *Brain Sciences*, **6**(4), 50. https://doi.org/10.3390/brainsci6040050

Jensen, P. S., Hinshaw, S. P., Kraemer, H. C., Lenora, N., Newcorn, J. H., Abikoff, H. B., March, J. S., Arnold, L. E., Cantwell, D. P., Conners, C. K., Elliott, G. R., Greenhill, L. L., Hechtman, L., Hoza, B., Pelham, W. E., Severe, J. B., Swanson, J. M., Wells, K. C., Wigal, T., & Vitiello, B. (2001). ADHD comorbidity findings from the MTA study: Comparing comorbid subgroups. *Journal of the American Academy of Child & Adolescent Psychiatry*, **40**(2), 147–158. https://doi.org/10.1097/00004583-200102000-00009

Kroll, J. F., & Bialystok, E. (2013). Understanding the consequences of bilingualism for language processing and cognition. *Journal of Cognitive Psychology*, **25**(5), 497–514. https://doi.org/10.1080/20445911.2013.799170

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “Frontal Lobe” tasks: A latent variable analysis. *Cognitive Psychology*, **41**(1), 49–100. https://doi.org/10.1006/cogp.1999.0734

Mor, B., Yitzhaki-Amsalem, S., & Prior, A. (2015). The joint effect of bilingualism and ADHD on executive functions. *Journal of Attention Disorders*, **19**(6), 527–541. https://doi.org/10.1177/1087054714527790

National Institute of Mental Health. (2009). *Research Domain Criteria (RDoC)*. https://www.nimh.nih.gov/research-priorities/rdoc/index.shtml

National Institute of Mental Health. (2018). *NIMH releases updates to its RDoC framework*. National Institute of Mental Health. https://www.nimh.nih.gov/news/science-news/2018/nimh-releases-updates-to-its-rdoc-framework.shtml

Neale, B. M., Medland, S. E., Ripke, S., Asherson, P., Franke, B., Lesch, K.-P., Faraone, S. V., Nguyen, T. T., Schäfer, H., Holmans, P., Daly, M., Steinhausen, H.-C., Freitag, C., Reif, A., Renner, T. J., Romanos, M., Romanos, J., Walitza, S., Warnke, A., … Nelson, S. (2010). Meta-analysis of genome-wide association studies of attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, **49**(9), 884–897. https://doi.org/10.1016/j.jaac.2010.06.008

Nigg, J. T., Willcutt, E. G., Doyle, A. E., & Sonuga-Barke, E. J. S. (2005). Causal heterogeneity in attention-deficit/hyperactivity disorder: Do we need neuropsychologically impaired subtypes? *Biological Psychiatry*, **57**(11), 1224–1230. https://doi.org/10.1016/j.biopsych.2004.08.025

Owens, E. B., Cardoos, S. L., & Hinshaw, S. P. (2015). Developmental progression and gender differences among individuals with ADHD. In R. A. Barkley (Ed.), *Attention-deficit hyperactivity disorder* (pp. 223–255). The Guildford Press.

Paap, K. R., & Greenberg, Z. I. (2013). There is no coherent evidence for a bilingual advantage in executive processing. *Cognitive Psychology*, **66**(2), 232–258. https://doi.org/10.1016/j.cogpsych.2012.12.002

Paradis, J. (2011). Individual differences in child English second language acquisition: Comparing child-internal and child-external factors. *Linguistic Approaches to Bilingualism*, **1**(3), 213–237. https://doi.org/10.1075/lab.1.3.01par

Polanczyk, G., de Lima, M. S., Horta, B. L., Biederman, J., & Rohde, L. A. (2007). The worldwide prevalence of ADHD: A systematic review and metaregression analysis. *American Journal of Psychiatry*, **164**(6), 942–948. https://doi.org/10.1176/ajp.2007.164.6.942

Polanczyk, G. V., Willcutt, E. G., Salum, G. A., Kieling, C., & Rohde, L. A. (2014). ADHD prevalence estimates across three decades: An updated systematic review and meta-regression analysis. *International Journal of Epidemiology*, **43**(2), 434–442. https://doi.org/10.1093/ije/dyt261

Rabbitt, P. (2005). Methodologies and models in the study of executive function. In P. Rabbitt (Ed.), *Methodology of frontal and executive function* (pp. 1–37). Psychology Press. https://www.taylorfrancis.com/books/e/9781135472030

Ramtekkar, U. P., Reiersen, A. M., Todorov, A., & Todd, R. D. (2010). Sex and age differences in attention deficit/hyperactivity disorder and diagnoses: implicationf for DSM-V and ICD-11. *Journal of the American Academy of Child and Adolescent Psychiatry*, **49**(3), 217–228.

Roberts, R. E., Ramsay Roberts, C., & Xing, Y. (2006). Prevalence of youth-reported DSM-IV psychiatric disorders among African, European, and Mexican American adolescents. *Journal of the American Academy of Child & Adolescent Psychiatry*, **45**(11), 1329–1337. https://doi.org/10.1097/01.chi.0000235076.25038.81

Roberts, W., Milich, R., & Barkley, R. A. (2015). Primary symptoms, diagnostic criteria, subtyping, and pevalence of ADHD. In R. A. Barkley (Ed.), *Attention-deficit hyperactivity disorder* (pp. 51–80). The Guildford Press.

Rothe, E. M. (2005). Considering cultural diversity in the management of ADHD in Hispanic patients. *Journal of the National Medical Association*, **97**(10 Suppl), 17S–23S.

Rowland, A. S., Skipper, B. J., Rabiner, D. L., Qeadan, F., Campbell, R. A., Naftel, A. J., & Umbach, D. M. (2018). Attention-deficit/hyperactivity disorder (ADHD): Interaction between socioeconomic status and parental history of ADHD determines prevalence. *Journal of Child Psychology and Psychiatry*, **59**(3), 213–222. https://doi.org/10.1111/jcpp.12775

Russell, A. E., Ford, T., & Russell, G. (2015). Socioeconomic associations with ADHD: Findings from a mediation analysis. *PLOS ONE*, **10**(6), e0128248. https://doi.org/10.1371/journal.pone.0128248

Russell, A. E., Ford, T., Williams, R., & Russell, G. (2016). The association between socioeconomic disadvantage and attention deficit/hyperactivity disorder (ADHD): A systematic review. *Child Psychiatry and Human Development*, **47**(3), 440–458. https://doi.org/10.1007/s10578-015-0578-3

Sciberras, E., Mueller, K. L., Efron, D., Bisset, M., Anderson, V., Schilpzand, E. J., Jongeling, B., & Nicholson, J. M. (2014). Language problems in children with ADHD: A community-based study. *Pediatrics*, **133**(5), 793–800. https://doi.org/10.1542/peds.2013-3355

Sorge, G. B., Toplak, M. E., & Bialystok, E. (2017). Interactions between levels of attention ability and levels of bilingualism in children's executive functioning. *Developmental Science*, **20**(1), e12408. https://doi.org/10.1111/desc.12408

Stevens, J., Harman, J. S., & Kelleher, K. J. (2004). Ethnic and regional differences in primary care visits for attention-deficit hyperactivity disorder. *Journal of Developmental & Behavioral Pediatrics*, **25**(5), 318.

Strand, S., Malmberg, L., & Hall, J. (2015). *English as an additional language (EAL) and educational achievement in England: An analysis of the National Pupil Database*. The Bell Foundation. https://www.bell-foundation.org.uk/app/uploads/2017/05/EALachievementStrand-1.pdf

Thorell, L. B., & Wåhlstedt, C. (2006). Executive functioning deficits in relation to symptoms of ADHD and/or ODD in preschool children. *Infant and Child Development*, **15**(5), 503–518. https://doi.org/10.1002/icd.475

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry*, **54**(2), 131–143. https://doi.org/10.1111/jcpp.12001

Willcutt, E. G. (2012). The prevalence of DSM-IV attention-deficit/hyperactivity disorder: A meta-analytic review. *Neurotherapeutics*, **9**(3), 490–499. https://doi.org/10.1007/s13311-012-0135-8

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: A meta-analytic review. *Biological Psychiatry*, **57**(11), 1336–1346. https://doi.org/10.1016/j.biopsych.2005.02.006

Zelazo, P. D., & Müller, U. (2002). Executive function in typical and atypical development. In U. Goswami (Ed.), *Blackwell handbook of childhood cognitive development* (pp. 445–469). Blackwell Publishers Ltd. http://onlinelibrary.wiley.com/doi/10.1002/9780470996652.ch20/summary

Cite this article: Sharma, CJM., Katsos, N., and Gibson, JL. (2022). Associations between bilingualism and attention-deficit hyperactivity disorder (ADHD)-related behavior in a community sample of primary school children. *Applied Psycholinguistics*. https://doi.org/10.1017/S0142716422000108