Reading and Writing (2022) 35:1651–1673
https://doi.org/10.1007/s11145-021-10240-8

Vocabulary limitations undermine bilingual children's reading comprehension despite bilingual cognitive strengths

Selma Babayiğit[1] · **Graham J. Hitch**[2] · **Swathi Kandru-Pothineni**[2] · **Annie Clarke**[2] · **Meesha Warmington**[3]

Accepted: 7 December 2021 / Published online: 10 February 2022

Abstract

Previous research reported bilingual cognitive strengths in working memory, executive function and novel-word learning skills (Bialystok in Psychol Bull 143:233–262, 2017; Kaushanskaya and Marian in Psychon Bull Rev 16:705–710, 2009). These skills should also support bilingual children's vocabulary and reading development, yet bilingual children show weaknesses in their second language vocabulary and reading comprehension skills. Our primary aim was to clarify these seemingly paradoxical reports by investigating the cognitive strengths and weaknesses associated with both bilingual experience and reading comprehension in a single study. The participants were 102 English-speaking monolingual children and 104 Hindi/Urdu-English speaking bilingual children (mean age = 118.26 months, *SD* = 11.23 months) in the UK. We tested children's vocabulary, working memory, executive function (cognitive inhibition, updating memory), novel-word learning, and reading skills. All testing was conducted in English. The findings supported the previous reports of bilingual cognitive strengths in working memory, novel-word learning and cognitive inhibition skills. However, despite their cognitive strengths and adequate word reading skills, the bilingual group displayed weaker reading comprehension than their monolingual peers. As anticipated, there was a direct association between bilingual children's smaller English vocabulary size and underperformance on reading comprehension. Along with word reading, vocabulary was the most powerful unique predictor of reading comprehension. The effects of cognitive control skills on reading comprehension were mixed and mostly indirect through word reading skills. These relations were comparable across the monolingual and bilingual groups. Together, our findings highlighted the importance of clear educational policies on oral language assessment and support in our increasingly multilingual classrooms.

Keywords Bilingual · Reading comprehension · Executive function · Working memory · Vocabulary · Novel-word learning

Extended author information available on the last page of the article

Introduction

It is proposed that learning to speak two languages entails selection of relevant language representations and suppression of irrelevant ones and this constant juggling confers certain cognitive advantages and disadvantages (Bialystok, 2017). Of particular relevance to the present study, are previous reports of bilingual advantage in working memory, executive function (EF), and novel-word learning skills and disadvantage in vocabulary knowledge (Bialystok et al., 2008; Kaushanskaya et al., 2014; Spencer & Wagner, 2017; Warmington et al., 2018). This is because working memory, EF, and lexical skills are also important component skills that underpin effective reading comprehension (Cirino et al., 2019; Jacobson et al., 2017). Yet, we do not know how these skills, which seem to be differentially influenced by the experience of bilingualism, relate to bilingual children's reading comprehension. Given the reports of a bilingual disadvantage in reading comprehension (Spencer & Wagner, 2017), the clarification of this issue is crucial for furthering our understanding of bilingual children's reading comprehension development.

Component skills of reading comprehension: vocabulary, working memory and EF

Reading comprehension entails processing of incoming information from text and its integration with the existing knowledge base in complex and dynamic ways (Perfetti & Stafura, 2014). The simple view of reading proposes two fundamental processing skills which underpin reading comprehension: decoding and linguistic comprehension skills (Hoover & Gough, 1990). The deciphering of the written code is the essential first step in reading comprehension. However, children who read words accurately and fluently can still experience reading comprehension difficulties (i.e., poor comprehenders), if they have weaknesses in linguistic comprehension. There is considerable evidence in support of the central role of the decoding and linguistic comprehension in reading comprehension but also a general acknowledgement that it is important to go beyond the simple view of reading and to examine the cognitive component processes which underpin linguistic comprehension (Gottardo et al., 2018) as well as noncognitive components, such as linguistic context (component model of reading, for an overview see Aaron et al., 2008). In the present study, our focus is on lexical, working memory, and EF skills, which are associated with both linguistic comprehension (Kim & Phillips, 2014) and bilingual cognitive effects (Bialystok, 2017).

There is no question that vocabulary knowledge lies at the interface of word reading and construction of a semantic representation of written text (comprehension). An abundance of research evidence has highlighted the powerful direct effect of vocabulary on reading comprehension (Gottardo et al., 2018; Quinn et al., 2015). We also know that vocabulary makes indirect contributions to reading comprehension through its facilitating effect on word recognition skills (Perfetti & Stafura, 2014; Quinn et al., 2015). However, understanding of the meaning of words alone is not sufficient for effective comprehension. There is also the need for the online

processing and integration of semantic information from the text and the existing knowledge base in the long-term memory. It is at this point that working memory skills are thought to play a crucial role in effective reading comprehension (Cirino et al., 2019).

Baddeley and Hitch (1974) conceptualised working memory as a multicomponent system consisting of an attentional control mechanism (i.e., the central executive) and two subsidiary buffer stores—phonological loop and visuo-spatial sketch pad. Others view working memory as a subcomponent of EF skills broadly defined as cognitive control skills, such as shifting, inhibiting irrelevant information, and updating working memory (Miyake et al., 2000). So, although the theoretical conceptualisation and operationalisation of working memory and EF can differ across studies, there is a consensus that working memory involves storage and processing of information whilst focusing attention and inhibiting irrelevant information during the performance of complex tasks (Miyake et al., 2000). Hence, in this study, we conceptualise working memory as EF plus storage skills, and EF as skills that primarily involve attentional control processes, such as inhibition of irrelevant information.

Working memory makes direct contributions to children's reading comprehension as well as indirect contributions through its positive relation to word reading skills (Cirino et al., 2019). Children who struggle with reading comprehension tend to also struggle with working memory and EF skills, such as inhibiting irrelevant information (De Beni & Palladino, 2000; Pimperton & Nation, 2010). However, it is also evident from the findings of studies in this area that this is a complex picture: some did not find a unique effect of inhibition skills on reading (Christopher et al., 2012), others reported that different working memory and EF skills are differentially related to different reading skills (Booth et al., 2010) and that the effect of EF skills on reading comprehension can also be indirect through word reading and oral language skills (Spencer et al., 2020).

Bilingual cognitive effects and reading comprehension

The working memory and EF skills lie at the heart of the models of second language proficiency (Linck et al., 2014). However, the extent to which learning to speak more than one language can shape brain development and affect cognitive processing of information remains a hotly debated area of research with many inconsistent and contested findings (Paap et al., 2015). A detailed evaluation of this debate is beyond the scope of the present study. It is sufficient to explain that the proposition that bilingualism enhances working memory and EF skills draws on the notion of parallel activation of linguistic representations in bilinguals. In a given context the lexical representations from both languages seem to be active, therefore bilingualism requires attentional control and inhibition skills to prevent intrusions from the context-irrelevant language (Green, 1998). Due to the inherent demands of bilingualism on the cognitive control systems, learning to speak two languages has been proposed to enhance inhibition and other related cognitive control skills (Bialystok, 2017). In support of these propositions, several meta-analytic studies reported evidence for

a bilingual advantage in working memory and EF skills with effect sizes ranging from small to large but there are also other meta-analytic studies which did not find a reliable effect of bilingualism (see Ware et al., 2020). Numerous factors, including task effects, small sample sizes, and demographic characteristics of monolingual and bilingual groups (e.g. social economic status) have been associated with these contradictory reports (Ware et al., 2020). Our primary concern in the present study was to clarify how the proposed constellation of bilingual cognitive-linguistic effects relate to bilingual children's reading comprehension skills. It is for this reason that studying the role of novel-word learning, vocabulary and cognitive control skills in bilingual reading comprehension has specific relevance for the present study.

The novel-word learning skills are fundamental for second language proficiency and have been associated with vocabulary (Alt et al., 2019), word reading (Warmington & Hulme, 2011) as well as working memory and EF skills (Kaushanskaya & Marian, 2009). Most notably, in one study on Hindi-English bilingual adults, Warmington et al. (2018) found that bilingual advantage in novel-word learning was related to bilinguals' enhanced cognitive control skills (working memory and inhibition skills). So, research on bilingual novel-word learning is particularly important to clarify the paradoxical reports of a bilingual advantage in novel-word learning but at the same time a disadvantage in vocabulary knowledge.

Bilingual adults and children as a group tend to know fewer words than their monolingual peers in their second language, which also tends to be the language of instruction in most of the reported studies (Bialystok & Luk, 2012; Spencer & Wagner, 2017). Numerous factors have been associated with bilingual vocabulary disadvantage, one of which is limited exposure: dividing a child's waking hours between two languages means less input from each individual language. Although the cause of the observed bilingual vocabulary disadvantage is likely to be multifactorial and continues to be debated (Soto-Corominas et al., 2020), it is well-established that a smaller vocabulary size undermines effective reading comprehension. In fact, several studies reported a direct association between limited bilingual vocabulary size and bilingual disadvantage in reading comprehension (Babayiğit, 2015; Babayiğit & Shapiro, 2020).

In general, relative to their monolingual peers, the school-age bilingual children seem to have age appropriate word reading accuracy and fluency skills but poorer linguistic comprehension and reading comprehension skills (Babayiğit, 2015; Babayiğit & Shapiro, 2020; Geva & Farnia, 2012; Lesaux et al., 2010; Raudszus et al., 2018). The converging evidence suggests that bilingual disadvantage in comprehension reflects oral language weaknesses, and in particular vocabulary skills. In fact when bilingual children's more limited English vocabulary knowledge was taken into account, bilingual disadvantage in reading comprehension disappeared (Babayiğit, 2014, 2015). Then, the question arises: what role do the cognitive strengths associated with bilingualism such as working memory play in bilingual reading comprehension?

Two meta-analytic studies reported evidence for a positive association between working memory and reading comprehension in bilingual groups (Jeon & Yamashita, 2014; Linck et al., 2014). The correlations between working memory and second language reading comprehension were reliable but not as strong as those for

vocabulary, decoding and grammatical skills (Jeon & Yamashita, 2014). These findings echo the mixed findings from individual studies. Some reported that working memory was uniquely related to bilingual reading comprehension but others failed to find any reliable unique relations once the powerful effects of vocabulary and word reading skills were taken into account (Babayiğit, 2014; Geva & Farnia, 2012). Likewise, whereas some reported a small but significant unique effect of EF (shifting and inhibition) skills on bilingual reading comprehension over and above oral language skills (Kieffer et al., 2013), others reported no unique relations between EF skills and reading comprehension (Raudszus et al., 2018). A number of factors including task characteristics might be associated with these seemingly inconsistent findings (Booth et al., 2010).

Taken together, it is difficult to reconcile these reports: a bilingual advantage in novel-word learning and cognitive control skills should support bilingual vocabulary and reading comprehension skills, yet there is clear evidence for a bilingual disadvantage in both these skills. It is interesting to note that, in none of the reviewed studies on bilingual reading comprehension was there any evidence of a bilingual advantage in either working memory or EF skills. That is why it is crucial that skills associated with bilingual effects are assessed simultaneously and that bilingual reading research should draw on the research evidence from both bilingual cognition and reading comprehension.

Present study

The broad aim of the present study was to clarify the reports of bilingual disadvantage in reading comprehension by investigating skills associated with both reading comprehension and bilingual cognitive effects (i.e., vocabulary, working memory, EF and novel-word learning skills). The critiques of the bilingual cognitive effects argue that the heterogeneity of the bilingual groups complicates the interpretation of findings (Paap et al., 2015). To address this issue, we recruited bilingual children from one of the largest linguistic minority groups in England who spoke English and Hindi/Urdu (CILT, 2011). Hindi and Urdu are often jointly referred to as Hindi/Urdu because linguistically and in its everyday spoken form Hindi is virtually identical to Urdu: both are Sanskrit languages and share morphological, syntactic and phonological structures and vocabulary (Kachru, 2009). Two specific research objectives guided the present study.

Our first research objective was to clarify the extent to which there was a bilingual advantage in working memory, EF (inhibition and updating) and novel-word learning skills, and a disadvantage in English vocabulary knowledge and reading comprehension. Given the inconsistent research evidence, we cautiously predicted a bilingual advantage in working memory, EF (inhibition and updating) and novel-word learning skills. Following the previous reports (Babayiğit, 2015; Spencer & Wagner, 2017), we anticipated there would be a bilingual disadvantage in English vocabulary knowledge and reading comprehension.

We also pursued the previous reports that vocabulary can modulate the bilingual cognitive and reading comprehension performance. Several studies found that

bilingual advantage in working memory, novel-word learning and verbal EF tasks (e.g. letter fluency) might be masked by bilingual vocabulary limitations (Bialystok et al., 2008; Blom et al., 2014; Buac & Kaushanskaya, 2014). In these studies, bilingual advantage in working memory, novel-word learning and verbal EF tasks was observed only when the vocabulary limitations of their bilingual group were taken into account as a covariant. Likewise, as noted before, some found that bilingual disadvantage in reading comprehension disappeared when the limited vocabulary knowledge of bilingual group was taken into account (Babayiğit, 2014, 2015); hence the importance of considering the vocabulary skills in bilingual cognitive effects.

The second research objective was to investigate how these cognitive-linguistic skills (working memory, EF, novel-word learning and vocabulary), which seem to be differentially influenced by the experience of bilingualism, relate to bilingual children's reading comprehension. We predicted that word reading, vocabulary, working memory and EF skills would be directly associated with reading comprehension, though, because of mixed reports, the prediction for working memory and EF skills must be tentative. As for novel-word learning, following the previous evidence for a specific role of novel-word learning in single word reading (Warmington & Hulme, 2011), we predicted that novel-word learning would be indirectly related to reading comprehension through its positive direct relation with word reading skills. Likewise, we predicted that vocabulary would make a positive indirect contribution to reading comprehension through its direct relation with word reading.

Method

Participants

The participants were 102 monolingual English-speaking children (59 girls and 43 boys) and 104 bilingual children who spoke Hindi/Urdu and English (53 girls and 51 boys). Children were recruited from eight primary schools and from the year groups 4, 5 and 6 in the UK. The mean age for the monolingual group was 115.92 months ($SD = 9.87$; min–max = 96–139 months) and for the bilingual group 120.56 months ($SD = 12.03$; min–max = 96–142 months). The mean age difference between the monolingual and bilingual groups was statistically significant, $t\ (204) = -3.03$, $p = 0.003$. Information for the parent education level, as an index of socioeconomic status, was available for 82 monolingual and 88 bilingual children. The two groups were relatively comparable on parental education levels, measured categorically from 1 (primary level) to 4 (higher education), chi-squared = 7.47, $df = 3$, $p = 0.058$. All bilingual children were born in the UK and had been exposed to the same duration of formal schooling in the UK as their monolingual peers. The monolingual children reported speaking only English. However, it is worth noting that all primary school children are introduced to a European language, mostly French, German or Spanish, at a very basic level in England. Bilingual children also completed an oral language background questionnaire adapted from Warmington et al. (2018) in which they rated their proficiency in both languages as well as their usage of each language at home and school. The responses to the oral questionnaires were checked by a

bilingual research assistant who spoke both Hindi/Urdu and English. As expected, the bilingual children were less likely to speak Hindi/Urdu than English at school, $t(103) = 25.56$, $p < 0.001$; but spoke Hindi/Urdu and English equally at home, $t(103) = 0.08$, $p = 0.94$. Parental reports indicated that most bilingual children's first exposure to English occurred at home. None of the bilingual children could read or write in Hindi/Urdu, which is in line with the previous reports: most minority language learners have very limited or no literacy skills in their heritage languages in England (Babayiğit & Shapiro, 2020).

Given the reports that individual differences in general processing speed can confound the monolingual-bilingual group comparisons on EF tasks (Hilchey & Klein, 2011), we conducted a preliminary check and confirmed that group difference in age-adjusted mean reaction time on a simple reaction time task was negligible, $\text{Mean}(SD)_{\text{Monolingual}} = 419.73\ (107.58)$, $\text{Mean}(SD)_{\text{Bilingual}} = 415.98\ (124.41)$, $F(1, 203) = 0.079$, $p = 0.780$, $\eta_p^2 = 0.00$. Therefore, the simple reaction time, which was not the focus of the current study, was dropped from the subsequent analyses (see online resource**).**

Measures

Reading comprehension

The York Assessment of Reading for Comprehension was used to assess children's reading comprehension (Snowling et al., 2009). A measure of children's text reading accuracy was also obtained from this test. Each child read aloud one narrative and one expository passage followed by open-ended oral questions and answers. The reliability of the text comprehension scores from the passage pairs was reported to range between 0.71 and 0.84. The parallel-form reliability of text reading accuracy was reported to range between 0.75 and 0.93.

Single word reading

Children's text-independent word recognition skills was assessed by the Single Word Reading Test 6–16 (Foster, 2007). The task was to read aloud a list of sixty words with graded difficulty. The Cronbach's alpha was reported to be 0.98.

Vocabulary

Children's receptive and expressive English vocabulary skills were assessed by the British Picture Vocabulary Scale-3 (BPVS-3; Dunn et al., 2009) and the Wechsler Abbreviated Scale of Intelligence –II (WASI-II; Wechsler, 2011), respectively. In the BPVS-3 (Dunn et al., 2009), children were asked to match a spoken word with one of the four pictures. In the WASI–II test (Wechsler, 2011), the task was to provide a definition for a spoken word. For the age groups 9–11 years, the Cronbach's

alpha and split-half reliability indices were reported to range between 0.89 and 0.97 in the BPVS-3 and 0.86-0.94 in the WASI-II.

Nonverbal IQ

Nonverbal ability was assessed using the Matrix Reasoning sub-test of the WASI-II (Wechsler, 2011). In this test, children viewed a series of incomplete matrices and completed each one by selecting the correct response option. The split-half reliability coefficient was reported to range between 0.85 and 0.89.

Novel-word learning

The novel-word learning skills were assessed by an object-name (visual-verbal) paired associate learning task taken from Warmington et al. (2018). This task required children to learn six novel Spanish names for six novel objects (see online resource). Prior to testing, it was confirmed that children did not know any of the Spanish words. The experiment was run using DMDX software (Forster & Forster, 2003). The task consisted of three phases: familiarization, training and test. Item presentation across all phases was randomized for each participant. The final score was the number of correct responses at immediate and delayed (two and seven-days post-training) tests.

During the familiarization phase children were presented with each object-name pair one at a time. Each pictured object appeared on the computer screen for 5000 ms while its name was simultaneously presented over headphones. Children were instructed to repeat each name aloud during presentation. In the training phase, each pictured object appeared one at a time on the computer screen and children were asked to provide the name of the object. If the response was incorrect or if the child failed to provide a response, corrective feedback was provided. This procedure was repeated until children learned the names of the objects to criterion (75% accuracy). Once they reached the criterion, they were presented with the test phase and asked to name the objects. No corrective feedback was provided for test trials.

Working memory

Backward digit span subtest from the Automated Working Memory Assessment (Alloway, 2007) assessed verbal working memory skills. The child was required to recall a sequence of spoken digits in reverse order. Formal testing procedures were followed. Test–retest reliability coefficient was reported as 0.86.

Executive function

The Simon task and a letter fluency task were used to assess nonverbal and verbal cognitive inhibition skills, respectively, and a visuo-spatial n-back task assessed updating skills. The Simon task and the n-back task were run using the DMDX software (Forster & Forster, 2003).

In the Simon task children saw a cat's face on a computer screen that was either located on the left or the right side of the screen. The cat's eyes would also be either blue or red. Children were instructed to press the right shift key, if the cat's eyes were red or the left shift key, if they were blue. Thus, depending on the location of the cat, the response key was either congruent or incongruent to the cat's location. The congruent and incongruent trials were presented in randomly sequenced mixed blocks. Each test block consisted of 40 congruent and 40 incongruent trials. The stimulus for each trial was displayed on the computer screen for approximately 650 ms. The congruency effect was calculated as the difference between the mean reaction time of incongruent and congruent trials.

The letter fluency task involves naming as many words as possible which start with a target letter while inhibiting irrelevant words, therefore it is generally considered to assess lexical access as well as verbal inhibition skills. Children were required to explicitly generate as many English words as they could think of within one minute that began with each specified letter (i.e., A, F, S). The mean number of accurately retrieved words from three trials were used in the data analyses.

The n-back task assessed the ability to update the contents of working memory. In this task, children were presented with three test blocks, each consisting of a series of 24 familiar objects presented for 650 ms each with an inter-stimulus interval of 1500 ms. Each block included a mixture of eight familiar pictured objects (ball, pencil, skirt, umbrella, chair, plant, book, kettle). Children completed two n-back tasks: 1-back required the children to indicate if the picture on the screen was the same as the previous one; 2-back required the children to indicate if the picture on the screen was the same as the one, they saw two pictures ago. Each trial within a block was preceded by a fixation cross displayed on the screen for approximately 500 ms. The test blocks were preceded by a practice block consisting of 10 trials. Children were required to give a response on every trial and were instructed to respond as quickly and accurately as possible. Total accuracy score was used in the data analyses.

General procedure

Children were tested individually in a quiet part of the school. The assessments were spread over three main sessions. In the first session, the novel-word learning task was conducted and a measure of immediate object naming score was obtained. The delayed object naming scores were obtained on day two and seven. Reading, working memory, IQ and EF measures were administered across these sessions. Each session lasted approximately 30 min.

Results

Descriptive results, correlations and group mean differences

Table 1 shows a summary of the descriptive statistics and Table 2 the intercorrelations between the measures. The data screening revealed one outlier score

Table 1 Descriptive statistics and group mean differences between the monolingual and bilingual groups

Measure	Group (*N*)	Mean (SS)	*SD* (SS)	Min–Max (SS)	Skewness	Mean difference (M-B) [c]	F^c	η_p^{2c}
Reading comprehension[a]	M (102)	64.48 (109.26)	7.38 (9.93)	43–81 (88)–(130)	−0.62	5.987	13.931	.094**
	B (104)	60.96 (102.85)	6.57 (8.40)	47–73 (81)–(124)	−1.22	*(1.486)*	*(1.916)*	*(.014)*
Text reading accuracy[a]	M (102)	57.59 (103.38)	8.58 (11.15)	40–82 (80)–(130)	0.78	0.645	0.166	.001
	B (104)	57.93 (102.38)	8.49 (11.07)	37–79 (79)–(130)	0.33	*(−3.311)*	*(4.864)*	*(.024*)*
Single word reading accuracy	M (102)	46.32	7.27	21–60	−2.16	1.177	1.524	.007
	B (104)	46.32	7.20	26–58	−2.82	*(−1.522)*	*(3.063)*	*(.013)*
Receptive vocabulary	M (102)	121.14 (93.43)	18.38 (16.13)	80–163 (70)–(133)	−0.66	13.115	29.067	.125**
	B (104)	110.98 (82.77)	18.48 (11.04)	71–154 (70)–(119)	−0.15	na	na	na
Expressive vocabulary[b]	M (102)	25.34 (50.33)	4.97 (9.15)	15–36 (31)–(78)	0.48	1.496	4.383	.021*
	B (104)	24.72 (47.20)	5.83 (8.63)	12–37 (23)–(63)	1.06	*(−0.878)*	*(2.119)*	*(.01)*
Novel-word learning	M (102)	8.39	3.43	0–17	−.81	−1.710	14.875	.068**
	B (104)	10.24	2.79	3–17	0.33	*(−2.554)*	*(32.994)*	*(.144 **)*
Working memory	M (102)	13.64 (101.91)	4.38 (14.42)	5–28 (71)–(140)	2.08	−3.746	27.556	.120**
	B (103)	17.46 (111.02)	5.54 (15.38)	6–33 (74)–(145)	0.63	*(−4.618)*	*(38.548)*	*(.161**)*
N-back	M (102)	84.83	15.01	34–126	−2.57	2.644	1.577	.01
	B (104)	83.68	15.32	37–109	−2.88	*(0.345)*	*(0.024)*	*(.00)*
Letter fluency	M (102)	12.22	3.82	4.44–24.44	1.64	−1.180	4.086	.02*
	B (104)	13.92	4.67	3.33–30.00	1.63	*(−2.167)*	*(13.296)*	*(.062**)*
Simon task	M (99)	50.97	48.93	−34.24–222.21	3.60	9.448	2.247	.011
	B (102)	42.57	48.66	−94.17–266.15	3.67	*(10.73)*	*(2.526)*	*(.012)*
Nonverbal IQ[b]	M (102)	13.64 (44.38)	4.54 (9.98)	4–26 (18)–(76)	1.06	−0.629	1.117	.005

Table 1 (continued)

Measure	Group (*N*)	Mean (SS)	*SD* (SS)	Min–Max (SS)	Skewness	Mean difference (M-B) [c]	F^{c}	η_p^{2c}
	B (104)	14.46 (45.90)	3.82 (7.84)	4–23 (25)–(65)	−0.36	*(− 1.956)*	*(11.361)*	*(.053**)*

Raw scores are presented with standard scores in parentheses when available

M Monolingual, *B* Bilingual, *SS* standard scores

$^{*}p \leq .05$. $^{**}p \leq .01$.

[a]Raw scores are ability scores

[b]Standard scores are T scores

[c]The values are based on ANCOVA with age as the covariate and those presented in italicised parentheses are based on ANCOVA with both age and receptive vocabulary as covariates; na = not applicable. The ηp^2 values of .01, .06 and .14 are defined as small, medium and large effect size, respectively (Cohen, 1988).

Table 2 Summary of Intercorrelations between the Measures for the Monolingual and Bilingual Groups

B	M														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. RC	–	.547**	.520**	.605**	.599**	.516**	.619**	.419**	.131	−.018	.196*	−.148	.434**	.158	−.150
2. TRA	.539**	–	.553**	.929**	.490**	.366**	.493**	.310**	.166	.058	.205*	−.051	.383**	.124	−.117
3. SWRA	.433**	.634**	–	.822**	.671**	.584**	.695**	.509**	.236*	.094	.293**	−.071	.455**	.203*	.362**
4. WR[a]	.547**	.942**	.857**	–	.633**	.509**	.646**	.438**	.219*	.081	.271**	−.066	.464**	.175	.081
5. RV	.489**	.310**	.520**	.432**	–	.650**	.985**	.483**	.232*	.146	.291**	−.140	.443**	.296**	.164
6. EV	.299**	.192	.465**	.330**	.695**	–	.771**	.516**	.162	.063	.334**	−.061	.254**	.174	.155
7. Vocabulary[a]	.470**	.299**	.537**	.432**	.983**	.815**	–	.522**	.231*	.137	.320**	−.131	.428**	.287**	.172
8. NWL	.292**	.284**	.374**	.351**	.225*	.202*	.233*	–	.219*	−.001	.140	−.311**	.102	.213*	.152
9. WM	.176	.338**	.284**	.349**	.222*	.194*	.229*	.133	–	.043	.186	−.153	.256**	−.024	−.008
10. N-Back	.215*	.192	.333**	.273**	.391**	.319**	.396**	.063	.209*	–	.072	−.087	−.056	.036	.191
11. LF	.288**	.182	.291**	.248*	.468**	.519**	.509**	.057	.227*	.221*	–	−.191	.291**	−.022	.106
12. Simon task	−.061	−.009	−.023	−.016	.069	.091	.078	−.031	−.147	−.006	−.006	–	−.096	.192	−.033
13. IQ	.271**	.155	.202*	.191	.403**	.276**	.395**	.120	.211*	.368**	.378**	−.121	–	.017	−.036
14. PE[b]	.235*	.119	.126	.134	.130	.161	.146	.030	.023	−.020	.175	.180	−.080	–	−.051
15. Age	−.078	−.043	.407**	.148	.559**	.540**	.588**	.059	.063	.269**	.409**	.005	.255**	.022	–

M monolingual, *B* Bilingual, *RC* reading comprehension, *TRA* Text reading accuracy, *SWRA* Single word reading accuracy, *WR* Word reading, *RV* Receptive vocabulary, *EV* Expressive vocabulary, *NWL* Novel-word learning, *WM* Working memory, *LF* Letter fluency, *PE* Parent education

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

[a]Composite measure, [b]n for monolingual group was 82 and bilingual group 88. Intercorrelations for the monolingual learners ($n = 102$) are presented above the diagonal and those for the bilingual learners ($n = 104$) below the diagonal

(monolingual) on the single word reading test, two extreme high scores (more than 2 *SDs* from the mean) (one monolingual and one bilingual) on the Simon task, and one extreme high score (bilingual) on letter fluency. These scores were changed to the next highest scores (Tabachnick & Fidell, 2001), which reduced the skewness indices considerably. The transformation of skewed scores on single word reading test (both monolingual and bilingual), working memory (monolingual), the Simon task (monolingual), and the n-back task (both monolingual and bilingual) did not change the results, therefore untransformed scores were used in the reported analyses.

As the groups differed in age, we included age as the covariate in the analyses of covariance (ANCOVA) tests. As summarised in Table 1, there was a bilingual advantage in novel-word learning, working memory and letter fluency, and a monolingual advantage in reading comprehension, receptive vocabulary, and expressive vocabulary. The effect sizes ranged from small-to-medium (Cohen, 1988). The two groups performed at comparable levels on text reading accuracy, single word reading accuracy, the n-back task, the Simon task, and nonverbal IQ.

Next, we repeated the ANCOVA tests with both age and receptive vocabulary as covariates to examine whether the smaller vocabulary size of bilingual children influenced the observed bilingual effects. When receptive vocabulary was considered, the mean group differences changed in favour of the bilingual group on all measures. Specifically, the bilingual advantage on novel-word learning, working memory and letter fluency increased and the effects sizes were now mostly within the medium range. Crucially, the bilingual disadvantage in reading comprehension became negligible.

Previous research has focused on receptive vocabulary knowledge and its effect on bilingual reading and cognitive performance. In this study, we were able to examine whether expressive vocabulary knowledge had similar effects on bilingual performance. Therefore, we conducted an ANCOVA with age and expressive vocabulary as covariates. The results showed that controlling for expressive vocabulary did not have any effect on group differences in cognitive performance or reading comprehension (see online resource for a summary table of ANCOVA with age and expressive vocabulary as covariates).

Path analyses

Preliminary considerations

Text reading accuracy and single word reading shared large variance and likewise, the two vocabulary measures (receptive and expressive) were strongly correlated with each other in both language groups (Table 2). Therefore, composite mean measures of word reading and vocabulary were computed to reduce the number of variables and redundancy in the subsequent path analyses.

The path analysis examined the direct and indirect contributions of word reading, working memory, EF measures, novel-word learning, and vocabulary to reading comprehension using the software IBM SPSS AMOS (Arbuckle, 2019). Nonverbal IQ, age and parental education were included in the model as background measures

as they were correlated with some of the measures in the path model (Table 2). Data screening revealed eight missing data points, which were imputed by full maximum likelihood estimation method (Enders & Bandalos, 2001). The adequacy of the model fit was evaluated by the following three indices: a nonsignificant χ^2 value, a comparative fit index (CFI) value at or above 0.95 and a RMSEA value below 0.05.

The model fit indices indicated excellent fit of the model to data from monolingual group, χ^2 (1) = 0.265, p = 0.606, CFI = 1.000, RMSEA = 0.000, with 90% CI = 0.000–0.211, and bilingual group, χ^2 (1) = 0.049, p = 0.825, CFI = 1.000, RMSEA = 0.000, with 90% CI = 0.000 to 0.157. The bias corrected bootstrapping procedure was implemented to compute the CIs for the parameter estimates and test the statistical significance of the indirect paths (with 10,000 bootstrap samples). Table 3 presents parameter estimates for the direct paths and Table 4 those for the indirect paths. Figure 1 summarises the statistically significant direct paths in monolingual and bilingual groups.

The path model explained 53% of variance in word reading and 56% of variance in reading comprehension in the monolingual group (all ps < 0.03). In the bilingual group, the total explained variance was 36% for word reading and 57% for reading comprehension (all ps < 0.04). Word reading, vocabulary and age made direct and unique contributions to reading comprehension in both monolingual and bilingual groups. Vocabulary and novel-word learning were directly related to word reading and indirectly related to reading comprehension in both groups. There were also some differences between the two groups. Working memory was directly related to bilingual but not monolingual word reading. Conversely, nonverbal IQ was directly related to monolingual but not bilingual word reading. These differences were also mirrored in indirect relations: whereas working memory was indirectly related to bilingual but not monolingual reading comprehension, nonverbal IQ was indirectly related to monolingual but not bilingual reading comprehension.

Next, we conducted a two-group path analysis to explore whether these observed group differences in parameter estimates were statistically significant. The Simon task was excluded from the two-group analysis due to heterogenous error variance. The model was a good fit to the combined data from both groups, χ^2 (4) = 0.973, p = 0.914, CFI = 1.000, RMSEA = 0.000, with 90% CI = 0.000–0.040 and the test of model invariance was nonsignificant, $\Delta\ \chi^2$ (13) = 11.676, p = 0.554, suggesting that the pattern and the strength of relations were invariant across the two groups. So, the observed monolingual and bilingual group differences in the path parameter estimates of working memory and IQ were statistically nonsignificant.

Discussion

A unique aspect of this study was to integrate the research on bilingual cognition and reading comprehension, to clarify how the cognitive-linguistic strengths and weaknesses associated with bilingualism relate to bilingual children's reading comprehension. This is crucially important to clarify the reports of bilingual disadvantage in reading comprehension which seem to contradict the reports of bilingual cognitive strengths. Moreover, the current study extended the previous research

Table 3 Parameter estimates for direct effects

Parameter	Monolingual					Bilingual				
	Std	US	*LL*	*UL*	*p*	Std	US	*LL*	*UL*	*p*
Vocabulary → word reading	.42	0.03	0.02	0.05	.001	.34	0.03	0.01	0.05	.008
NWL → word reading	.24	0.12	0.03	0.21	.008	.26	0.17	0.07	0.27	.001
WM → word reading	.01	0.00	− 0.08	0.07	.953	.21	0.07	0.02	0.13	.005
N-Back → word reading	.05	0.01	− 0.01	0.02	.501	.13	0.02	− 0.01	0.04	.184
Letter fluency → word reading	.06	0.03	− 0.05	0.11	.527	.04	0.01	− 0.06	0.09	.702
Simon task → word reading	.09	0.00	0.00	0.01	.247	− .03	0.00	− 0.01	0.01	.731
Nonverbal IQ → word reading	.26	0.10	0.04	0.16	.002	− .05	− 0.02	− 0.11	0.06	.618
Age → word reading	.02	0.00	− 0.02	0.03	.780	− .06	− 0.01	− 0.04	0.02	.560
PE → word reading	− .01	− 0.02	− 0.29	0.23	.822	.07	0.10	− 0.15	0.34	.456
Word reading → reading comp	.32	1.83	0.65	2.97	.002	.35	1.62	0.90	2.30	.001
Vocabulary → reading comp	.38	0.17	0.05	0.29	.005	.52	0.19	0.11	0.26	.001
NWL → reading comp	.12	0.35	− 0.08	0.84	.106	.06	0.19	− 0.33	0.65	.457
WM → reading comp	− .09	− 0.20	− 0.53	0.19	.289	− .10	− 0.16	− 0.42	0.13	.264
N-Back → reading comp	− .04	− 0.03	− 0.11	0.06	.575	.01	0.01	− 0.08	0.08	.892
Letter fluency → reading comp	− .03	− 0.09	− 0.50	0.31	.703	.10	0.18	− 0.13	0.52	.238
Simon task → reading comp	− .05	− 0.01	− 0.04	0.03	.589	− .12	− 0.02	− 0.05	0.01	.140
Nonverbal IQ → reading comp	.13	0.28	− 0.14	0.70	.181	.10	0.22	− 0.09	0.54	.163
PE → reading comp	− .04	− 0.38	− 1.88	1.05	.634	.14	0.98	− 0.08	2.06	.069
Age → reading comp	− .26	− 0.27	− 0.43	− 0.11	.001	− .52	− 0.37	− 0.48	− 0.25	.001

Std Standardized estimate, *US* unstandardized estimate, *LL* lower limit confidence interval, *UP* upper limit confidence interval, *NWL* Novel-word learning, *WM* working memory, *PE* parent education, *Reading comp.* reading comprehension

Table 4 Parameter estimates for indirect paths to reading comprehension

	Monolingual			Bilingual		
	LL	*UL*	*p*	*LL*	*UL*	*p*
Vocabulary	0.022	0.119	.001	0.013	0.084	.005
Novel-word learning	0.048	0.519	.007	0.115	0.512	.001
Working memory	−0.166	0.152	.938	0.034	0.229	.004
N-Back	−0.019	0.048	.443	−0.012	0.058	.256
Letter fluency	−0.086	0.235	.474	−0.88	0.172	.680
Simon task	−0.004	0.019	.203	−0.015	0.010	.710
Nonverbal IQ	0.044	0.411	.003	−0.187	0.105	.575

Unstandardized estimates are presented

LL lower limit confidence interval, *UL* upper limit confidence interval

by focusing on a large sample of a well-defined group of bilingual children in the UK, which has not been studied before. We found that despite bilingual strengths in working memory, inhibition, and novel-word learning skills, which were all positively related to bilingual children's reading skills, there was a bilingual disadvantage in vocabulary and reading comprehension. Our findings have also supported the previous reports that smaller vocabulary size of bilingual children can lead to underestimation of their performance on cognitive and reading measures. The findings from the path analyses not only confirmed the powerful direct role of vocabulary and word reading skills in bilingual reading comprehension but also highlighted indirect contributions of vocabulary, novel-word learning and working memory to reading comprehension via word reading skills. None of the EF measures made a direct contribution to bilingual reading in this study. Similar results were observed for the monolingual group and the pattern and strength of relations were largely invariant across the monolingual and bilingual groups.

Bilingual effects on cognition and reading

Our findings from this study were in accordance with the previous reports of bilingual advantage in working memory, letter fluency and novel-word learning (Bialystok et al., 2008; Kaushanskaya & Marian, 2009; Warminton et al., 2018), and disadvantage in reading comprehension and vocabulary (Babayiğit, 2015). The failure to observe a bilingual advantage in the Simon and updating (n-back) tasks was not entirely surprising given the previous inconsistent reports (Bialystok, 2017). These findings further signify the importance of caution when drawing conclusions based on a single measure of EF and support the view that EF is not a unitary construct (Ware et al., 2020).

Further, we found that bilingual children's weaknesses in the breadth of English vocabulary knowledge was evident even when they displayed specific cognitive strengths in novel-word learning, general cognitive reasoning, and working memory skills. Therefore, these findings point to external factors, namely differences in

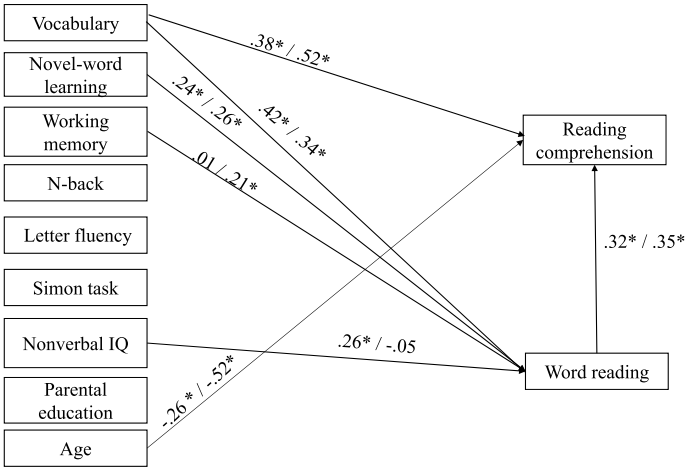

Fig. 1 Summary of statistically significant direct paths and relevant standardized parameter estimates for monolingual/bilingual groups (*p<.01)

linguistic input or exposure to diverse vocabulary as a possible explanation for bilingual children's lower vocabulary knowledge.

Crucially, our findings showed that despite their cognitive strengths, bilingual children's smaller English vocabulary size has a direct bearing on their reading comprehension performance: the bilingual disadvantage in reading comprehension became negligible after considering differences in receptive vocabulary size. In fact, considering receptive vocabulary size, which is a measure of lexical diversity, shifted all mean group differences in favour of the bilingual group. Specifically, the bilingual advantage in working memory, novel-word learning and letter fluency increased providing support for the previous reports that smaller bilingual vocabulary size may lead to underestimation of bilingual cognitive effects (Bialystok et al., 2008; Blom et al., 2014; Buac & Kaushanskaya, 2014).

As noted before, receptive vocabulary has been the primary focus of prior research investigating the role of bilingual vocabulary gap in reading comprehension and cognitive performance (Babayiğit, 2015; Bialystok et al., 2008; Blom et al., 2014; Buac & Kaushanskaya, 2014). Our findings extended previous research by showing that in contrast to receptive vocabulary, expressive vocabulary knowledge had no effect on bilingual cognitive or reading comprehension performance. Although reliable, the bilingual gap for expressive vocabulary was small and its impact on reading comprehension and cognitive performance was negligible. Together these results suggest that it is the vocabulary breath rather than depth that matters most when examining bilingual reading comprehension and cognitive performance among children of this age group.

By focusing on a well-defined group of Hindi/Urdu-English speaking bilingual children who have been exposed to the English language and formal schooling in English from a very early age with comparable parental education levels to those of their monolingual peers, we addressed an important limitation of previous studies

in the UK, which mostly examined heterogeneous language groups from predominantly lower social economic backgrounds (Babayiğit & Shapiro, 2020). Our findings extended the previous reports by showing that bilingual vocabulary and reading comprehension gap cannot be explained by the duration of formal schooling or socioeconomic factors alone. Even cognitively proficient bilingual children can show evidence of vocabulary gap which then impacts on their reading comprehension as well as cognitive performance.

Component skills of reading comprehension: vocabulary, working memory and EF

In this study, vocabulary and word level reading skills made direct contributions to reading comprehension performance in both monolingual and bilingual groups. This finding extends the previous reports and highlights that even when the contributions of other important cognitive control skills are taken into account, word reading and vocabulary skills are critical for effective reading comprehension in primary school-age children irrespective of children's language background.

As anticipated, vocabulary and novel-word learning were directly related to word reading and made indirect contributions to bilingual reading comprehension through word reading. This is an important novel finding which not only supports the proposition that novel-word learning plays a unique and direct role in word reading skills over and above vocabulary skills (Warmington & Hulme, 2011) but also highlights its indirect role in reading comprehension in both monolingual and bilingual groups. As for the working memory skills, contrary to previous reports (Christopher et al., 2012), we did not find a direct relation between working memory and reading comprehension in either the bilingual or monolingual group. Likewise, once the powerful effects of other measures were considered, none of the EF measures was directly related to word reading or reading comprehension in either group contradicting the previous reports of unique relations between EF and reading (Cirino et al., 2019; Jacobson et al., 2017).

Further scrutiny of our findings indicated that there were in fact reliable and positive bivariate relations between some EF tasks and reading: inhibition (letter fluency) shared small and reliable variance with word reading and reading comprehension in both monolingual and bilingual groups. The updating working memory task correlated with both word reading and reading comprehension in the bilingual group (but not in the monolingual group). It seems that for this age group the powerful effects of vocabulary and word reading override those of cognitive control skills. Finally, it is notable that the Simon task was not related to reading in either group, which echoed the findings of Raudszus et al. (2018) who also used the Simon task as a measure of inhibition and failed to find any relations with reading suggesting possible task effects.

Along with task effects, sample characteristics may also explain these mixed findings. Studies which found unique effects of EF and working memory on word reading and reading comprehension tend to be based on samples with a large proprotion of children with reading difficulties and also tend to use latent measures which

account for measurement error (Cirino et al., 2019; Jacobson et al., 2017; Kieffer & Christodoulou, 2020). Nonetheless, our findings were in accordance of those of Jeon and Yamashita (2014) who also found that oral language (vocabulary) and decoding were the strongest correlates of bilingual reading comprehension.

General limitations and the way forward

The present study examined the key bilingual cognitive-linguistic strengths and weaknesses which relate to reading comprehension in a single study. So, our testing battery was already too large to include multiple measures of each construct and use latent measures to account for measurement error. To address measurement error and clarify the possible task effects, further research needs to examine different domains of EF skills (verbal and nonverbal) with multiple measures and use latent measures to examine their respective contributions to different reading comprehension tasks. The question as to what extent the effect of working memory and EF skills on reading comprehension are more pronounced in children with reading difficulties is also crucial to clarify. Further, the age group of the current sample crossed the boundary of 'learning to read (approximately before 10/11 years of age)' to 'reading to learn (after the age of 11)'. Therefore, it is possible that the observed pattern of relations may differ if older bilingual and monolingual children are tested (Christopher et al., 2012). There is also the need to obtain objective measures of bilingual children's home language proficiency and caution is required when generalising the present findings to other bilingual groups in different educational contexts. Finally, it should be highlighted that the relations of reading comprehension with vocabulary, working memory and EF skills are likely to be reciprocal and more complex than depicted in a simple linear path model.

Conclusion and implications

The most important novel contribution of the present study is that there is a bilingual disadvantage in English reading comprehension and vocabulary size even when bilingual children show important cognitive-linguistic strengths which are positively related to their reading and vocabulary skills. Our findings support the previous reports that it is primarily the limitations in English vocabulary size that is holding back bilingual children from performing as well as their monolingual peers on reading comprehension measures. Given the evidence that a smaller network of lexical knowledge may undermine efficient vocabulary acquisition (Dockrell & Messer, 2004) and that bilingual vocabulary gap can persist into adulthood, further research is warranted to clarify the long-term effects of bilingual vocabulary limitations on reading comprehension, as well as cognitive and academic performance.

At this point it is important to note that bilingual children's limited English language proficiency is not confined to vocabulary, similar limitations in their English grammatical skills have also been found to undermine their reading comprehension performance (Babayiğit & Shapiro, 2020). Intervention studies show evidence that bilingual children benefit from broader oral language support (Dockrell et al.,

2010). Our findings further highlight that pedagogic programmes with a focus on vocabulary and oral language are vitally important to translate any cognitive benefits of bilingualism to positive educational outcomes in our increasingly multilingual classrooms.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11145-021-10240-8.

Acknowledgements At the time when this study was conducted Swathi Kandru-Pothineni and Annie Clarke were affiliated with the University of York, United Kingdom. This study was supported by The Leverhulme Trust (RPG-2013-056); PI Meesha Warmington). We are immensely grateful for the support and participation of the headteachers, teachers and children in the United Kingdom. Thanks go to the Research Assistants: Amy Atkins, Aimee Code and Adam Eggleston who assisted with data collection.

References

Aaron, P. G., Joshi, R. M., Gooden, R., & Bentum, K. E. (2008). Diagnosis and treatment of reading disabilities based on the component model of reading. *Journal of Learning Disabilities, 41*(1), 67–84. https://doi.org/10.1177/0022219407310838

Alloway, T. P. (2007). *Automated working memory assessment (AWMA)*. Pearson Assessment.

Alt, M., Arizmendi, G. D., Gray, S., Hogan, T. P., Green, S., & Cowan, N. (2019). Novel word learning in children who are bilingual: Comparison to monolingual peers. *Journal of Speech, Language, and Hearing Research, 62*(7), 2332–2360. https://doi.org/10.1044/2019_JSLHR-L-18-0009

Arbuckle, J. L. (2019). *Amos (Version 26.0) [Computer Program]*. Chicago, IL: IBM SPSS.

Babayiğit, S. (2014). The role of oral language skills in reading and listening comprehension of text: A comparison of monolingual (L1) and bilingual (L2) speakers of English language. *Journal of Research in Reading, 37*(S1), S22–S47. https://doi.org/10.1111/j.1467-9817.2012.01538.x

Babayiğit, S. (2015). The relations between word reading, oral language, and reading comprehension in children who speak English as a first (L1) and second language (L2): A multigroup structural analysis. *Reading and Writing, 28*, 527–544. https://doi.org/10.1007/s11145-014-9536-x

Babayiğit, S., & Shapiro, L. (2020). Component skills that underpin listening comprehension and reading comprehension in learners with English as first and additional language. *Journal of Research in Reading, 43*, 78–97. https://doi.org/10.1111/1467-9817.12291

Baddeley, A. D., & Hitch, G. J. (1974). Working memory. In G. H. Bower (Ed.), *The psychology of learning and motivation* (pp. 47–89). Academic Press.

Bialystok, E., & Luk, G. (2012). Receptive vocabulary differences in monolingual and bilingual adults. *Bilingualism: Language and Cognition, 15*, 397–401. https://doi.org/10.1017/S136672891100040X

Bialystok, E. (2017). The bilingual adaptation: How minds accommodate experience. *Psychological Bulletin, 143*, 233–262. https://doi.org/10.1037/bul0000099

Bialystok, E., Craik, F. I. M., & Luk, G. (2008). Lexical access in bilinguals: Effects of vocabulary size and executive control. *Journal of Neurolinguistics, 21*, 522–538. https://doi.org/10.1016/j.jneuroling.2007.07.001

Blom, E., Küntay, A. C., Messer, M., Verhagen, J., & Leseman, P. (2014). The benefits of being bilingual: Working memory in bilingual Turkish-Dutch children. *Journal of Experimental Child Psychology, 128*, 105–119. https://doi.org/10.1016/j.jecp.2014.06.007

Booth, J. N., Boyle, J. M. E., & Kelly, S. W. (2010). Do tasks make a difference? Accounting for heterogeneity of performance of children with reading difficulties on tasks of executive function: Findings from a meta-analysis. *British Journal of Developmental Psychology, 28*, 133–176. https://doi.org/10.1348/026151009X485432

Buac, M., & Kaushanskaya, M. (2014). The relationship between linguistic and non-linguistic cognitive control skills in bilingual children from low socio-economic backgrounds. *Frontiers in Psychology, 5*, 1098. https://doi.org/10.3389/fpsyg.2014.01098

Christopher, M. E., Miyake, A., Keenan, J. M., Pennington, B., Defries, J. C., Wadsworth, S. J., et al. (2012). Predicting word reading and comprehension with executive function and speed measures across development: A latent variable analysis. *Journal of Experimental Psychology: General, 141*, 470–488. https://doi.org/10.1037/a0027375

CILT. (2011). *National Centre for Languages (operating as part of the CfBT Education Trust).* http://www.cilt.org.uk/home/research_and_statistics/statistics/languages_in_the_population/other_related_sources.aspx.

Cirino, P. T., Miciak, J., Ahmed, Y., Barnes, M. A., Taylor, W. P., & Gerst, E. H. (2019). Executive function: Association with multiple reading skills. *Reading and Writing, 32*, 1819–1846. https://doi.org/10.1007/s11145-018-9923-9

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Erlbaum.

De Beni, R., & Palladino, P. (2000). Intrusion errors in working memory tasks: Are they related to reading comprehension ability? *Learning and Individual Differences, 12*, 131–143. https://doi.org/10.1016/S1041-6080(01)00033-4

Dockrell, J. E., & Messer, D. J. (2004). Lexical acquisition in the early school years. In R. A. Berman (Ed.), *Language development across childhood and adolescence* (pp. 35–52). John Benjamins.

Dockrell, J. E., Stuart, M., & King, D. (2010). Supporting early oral language skills for English language learners in inner city preschool provision. *British Journal of Educational Psychology, 80*, 497–515. https://doi.org/10.1348/000709910X493080

Dunn, L. M., Dunn, D. M., & National Foundation for Educational Research. (2009). *The British Picture Vocabulary Scale: 3*. London: GL Assessment.

Enders, C. K., & Bandalos, D. L. (2001). The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling: A Multidisciplinary Journal, 8*, 430–457. https://doi.org/10.1207/S15328007SEM0803_5

Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, & Computers*, *35*, 116–124. https://doi.org/10.3758/BF03195503

Foster, H. (2007). *Single word reading test 6–16*. GL Assessment.

Geva, E., & Farnia, F. (2012). Developmental changes in the nature of language proficiency and reading fluency paint a more complex view of reading comprehension in ELL and EL1. *Reading and Writing, 25*, 1819–1845. https://doi.org/10.1007/s11145-011-9333-8

Gottardo, A., Mirza, A., Koh, P. W., Ferreira, A., & Javier, C. (2018). Unpacking listening comprehension: The role of vocabulary, morphological awareness, and syntactic knowledge in reading comprehension. *Reading and Writing, 31*, 1741–1764. https://doi.org/10.1007/s11145-017-9736-2

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition, 1*, 67–81. https://doi.org/10.1017/S1366728998000133

Hilchey, M. D., & Klein, R. M. (2011). Are there bilingual advantages on nonlinguistic interference tasks? Implications for the plasticity of executive control processes. *Psychonomic Bulletin & Review*, *18*, 625–658. https://doi.org/10.3758/s13423-011-0116-7

Hoover, W. A., & Gough, P. B. (1990). The simple view of reading. *Reading and Writing, 2*, 127–160. https://doi.org/10.1007/bf00401799

Jacobson, L. A., Koriakin, T., Lipkin, P., Boada, R., Frijters, J. C., Lovett, M. W., et al. (2017). Executive functions contribute uniquely to reading competence in minority youth. *Journal of Learning Disabilities, 50*, 422–433. https://doi.org/10.1177/0022219415618501

Jeon, E. H., & Yamashita, J. (2014). L2 reading comprehension and its correlates: A meta-analysis. *Language Learning, 64*, 160–212. https://doi.org/10.1111/lang.12034

Kachru, Y. (2009). Hindi-Urdu. In B. Comrie (Ed.), *The worlds' major languages* (pp. 399–416). Routledge.

Kaushanskaya, M., Gross, M., & Buac, M. (2014). Effects of classroom bilingualism on task-shifting, verbal memory, and word learning in children. *Developmental Science, 17*, 564–583. https://doi.org/10.1111/desc.12142

Kaushanskaya, M., & Marian, V. (2009). The bilingual advantage in novel word learning. *Psychonomic Bulletin & Review, 16*, 705–710. https://doi.org/10.3758/PBR.16.4.705

Kieffer, M. J., Vukovic, R. K., & Berry, D. (2013). Roles of attention shifting and inhibitory control in fourth-grade reading comprehension. *Reading Research Quarterly, 48*, 333–348.

Kieffer, M. J., & Christodoulou, J. A. (2020). Automaticity and control: How do executive functions and reading fluency interact in predicting reading comprehension? *Reading Research Quarterly, 55*, 147–166. https://doi.org/10.1002/rrq.289

Kim, Y. S., & Phillips, B. (2014). Cognitive correlates of listening comprehension. *Reading Research Quarterly, 49*, 269–281. https://doi.org/10.1002/rrq.74

Lesaux, N. K., Crosson, A. C., Kieffer, M. J., & Pierce, M. (2010). Uneven profiles: Language minority learners' word reading, vocabulary, and reading comprehension skills. *Journal of Applied Developmental Psychology, 31*, 475–483. https://doi.org/10.1016/j.appdev.2010.09.004

Linck, J. A., Osthus, P., Koeth, J. T., & Bunting, M. F. (2014). Working memory and second language comprehension and production: A meta-analysis. *Psychonomic Bulletin & Review, 21*, 861–883.

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*, 49–100. https://doi.org/10.1006/cogp.1999.0734

Paap, K. R., Johnson, H. A., & Sawi, O. (2015). Bilingual advantages in executive functioning either do not exist or are restricted to very specific and undetermined circumstances. *Cortex, 69*, 265–278. https://doi.org/10.1016/j.cortex.2015.04.014

Perfetti, C., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading, 18*, 22–37. https://doi.org/10.1080/10888438.2013.827687

Pimperton, H., & Nation, K. (2010). Suppressing irrelevant information from working memory: Evidence for domain-specific deficits in poor comprehenders. *Journal of Memory and Language, 62*, 380–391. https://doi.org/10.1016/j.jml.2010.02.005

Quinn, J. M., Wagner, R. K., Petscher, Y., & Lopez, D. (2015). Developmental relations between vocabulary knowledge and reading comprehension: A latent change score modeling study. *Child Development, 86*, 159–175. https://doi.org/10.1111/cdev.12292

Raudszus, H., Segers, E., & Verhoeven, L. (2018). Lexical quality and executive control predict children's first and second language reading comprehension. *Reading and Writing, 31*, 405–424. https://doi.org/10.1007/s11145-017-9791-8

Snowling, M., Stothard, S. E., Clarke, P., Bowyer-Crane, C., Harrington, A., Truelove, E., et al. (2009). *York assessment of reading for comprehension*. GL Assessment.

Soto-Corominas, A., Paradis, J., Rusk, B. V., Marinova-Todd, S., & Zhang, X. (2020). Oral language profiles of english second language learners in adolescence: cognitive and input factors influence how they compare to their monolingual peers. *Studies in Second Language Acquisition, 42*, 697–720. https://doi.org/10.1017/S0272263119000767

Spencer, M., Richmond, M. C., & Cutting, L. E. (2020). Considering the role of executive function in reading comprehension: a structural equation modeling approach. *Scientific Studies of Reading, 24*, 179–199. https://doi.org/10.1080/10888438.2019.1643868

Spencer, M., & Wagner, R. K. (2017). The comprehension problems for second-language learners with poor reading comprehension despite adequate decoding: A meta-analysis. *Journal of Research in Reading, 40*, 199–217. https://doi.org/10.1111/1467-9817.12080

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics* (4th ed.). Allyn and Bacon.

Ware, A. T., Kirkovski, M., & Lum, J. A. G. (2020). Meta-analysis reveals a bilingual advantage that is dependent on task and age. *Frontiers in Psychology, 11*, 1458. https://doi.org/10.3389/fpsyg.2020.01458

Warmington, M., Kandru-Pothineni, S., & Hitch, G. J. (2018). Novel word learning, executive control and working memory: A bilingual advantage. *Bilingualism: Language and Cognition*. https://doi.org/10.1017/S136672891800041X

Warmington, M., & Hulme, C. (2011). Phoneme awareness, visual-verbal paired associate learning and rapid automatized naming as predictors of individual differences in reading ability. *Scientific Studies of Reading, 16*, 45–62. https://doi.org/10.1080/10888438.2010.534832
Wechsler, D. (2011). *Wechsler Abbreviated Scale of Intelligence* (2nd ed.). Pearson.

Authors and Affiliations

Selma Babayiğit[1] · Graham J. Hitch[2] · Swathi Kandru-Pothineni[2] · Annie Clarke[2] · Meesha Warmington[3]

✉ Selma Babayiğit
selma.babayigit@uwe.ac.uk

[1] Department of Social Sciences, University of the West of England (Bristol), Coldharbour Lane, Frenchay, Bristol BS16 1QY, UK

[2] University of York, York, UK

[3] University of Sheffield, Sheffield, UK