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An Investigation of the Multilingual and Bi-dialectal Advantage in Executive Control

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Abstract

We examined the effect of speaking more than one language (multilingualism) or two dialects of the same language (bi-dialectalism) on executive control (EC) by administering seven EC tasks to 46 multilingual, 72 bi-dialectal and 47 monolingual young adults. We used the EC model of Miyake, Friedman, Emerson, Witzki, Howerter and Wager (2000) according to which EC comprises three components: working memory, task-switching and inhibition. We also tested two theoretical views regarding the locus of the bilingual advantage: first, that bilingualism affects specific EC components and, second, that bilingualism has a more general effect on the whole EC network. Miyake et al.'s (2000) model was a good fit to our EC data. We also found that both multilinguals and bi-dialectals had significantly higher EC scores than monolinguals. Moreover, both the multilingual and the bi-dialectal advantage was found in overall EC ability and could not be attributed to a specific EC component.

Keywords: bilingualism; multilingualism; bi-dialectalism; typological distance; executive control; dialects

Introduction

It is now estimated that bilingual speakers -individuals who use more than one language on a regular basis- make up the majority of the world population (e.g. Grosjean & Li, 2013). As a result, bilingualism and its possible neurocognitive effects have recently become a topic of central interest for researchers working within linguistics, psychology and cognitive neuroscience (e.g. Bialystok, 2017; Paap, 2019).

Within this growing body of work, some researchers have suggested the idea that regularly using more than one language is an experience that enhances a specific neurocognitive system, executive control (e.g. Bialystok, 2017). The main rationale for the bilingual executive control advantage hypothesis (BECA) is the well-established finding that, when a bilingual speaks in one of her languages, the other language remains active and potentially available for use (Kroll, Dussias, Bogulski & Kroff, 2012). In this respect, the fluent use of the intended language requires some sort of domain-general mechanism that will select the appropriate language and will prevent intrusions from the non-relevant language. According to BECA, this domain-general mechanism is found in the EC system. Thus, the constant experience of using EC to manage two simultaneously active, conflicting language systems during everyday communication is a form of mental exercise that results in better EC skills in bilinguals (e.g. Bialystok, 2017).

In this context, our study aimed to examine the BECA by comparing groups of multilingual, bi-dialectal and monolingual young adult participants. As part of this research, we were particularly interested in investigating whether an EC advantage would be found even for bi-dialectals -that is, speakers of two very similar dialects of the same language. As a secondary goal, we wanted to adjudicate between two broad theoretical accounts regarding the cognitive locus of the bilingual EC performance advantage (if indeed found). Does bilingualism/bi-dialectalism affect specific cognitive components or the EC network as a whole? In the next section, we briefly introduce the influential theoretical model of EC proposed by Miyake et al. (2000) and review the extensive literature on the effect of bilingualism on EC. We then present our experimental study.

Bilingualism and Executive Control

Executive control (EC) refers to a domain-general system, which, according to the widely-accepted framework of Miyake et al. (2000), comprises three core processes that are distinguishable but yet moderately interrelated. These executive functions include *shifting* or *task-switching* (the ability to flexibly switch between rules, representations or tasks), *updating and monitoring the contents of working memory*[1] (coding and monitoring information in working memory for relevance to a given task and revising it in case it is no longer relevant) and *inhibition* (the ability to inhibit dominant responses and irrelevant information).

Direct empirical support to BECA has mainly come from behavioral research showing superior (faster and/or more accurate) performance for bilinguals in a variety of EC tasks. Nevertheless, more recently, many studies failed to replicate the bilingual advantage in EC tasks (e.g. Paap, 2019). These results led some researchers to suggest that the bilingual cognitive advantage does not exist (e.g. Paap, 2019). The most recent meta-analyses reveal varying results, with effect sizes ranging from null (Lehtonen, Soveri, Laine, Jarvenpaa,

[1]In this paper, we consider the terms *updating* and *working memory* to be interchangeable and use the term *working memory* instead of *updating* because, in general, it is more commonly used in the literature.

de Bruin & Antfolk, 2018) to small-to-moderate, in the direction of a bilingual advantage (Grundy & Timmer, 2016).

Mixed results have been also reported with regards to whether the bilingual EC advantage is found for speakers of two closely related languages or dialects. EC advantages, for instance, have been reported for Spanish-Catalan (e.g. Costa, Hernandez, Costa-Faidella & Sebastian-Galles, 2009) and Sardinian-Italian bilinguals (e.g. Garraffa, Obregon & Sorace, 2017). Spanish-Catalan and Sardinian-Italian have a lexical similarity of 85% (Lewis, Gary & Fennig, 2014). This is exactly on the cut-off point for two linguistic varieties being dialects of the same language according to the *Ethnologue* (Lewis et al., 2014). Another study conducted by Antoniou, Grohmann, Kambanaros and Katsos (2016) in the context of Cyprus found an EC advantage for both multilingual (speakers of Cypriot Greek, Standard Modern Greek and other languages) and bi-dialectal children (in Cypriot Greek and Standard Modern Greek). Crucially, again, Cypriot Greek (CG) and Standard Modern Greek (SMG) have a high lexical similarity of 84-92% (Lewis et al., 2014). Other studies, however, failed to find evidence for an advantage with various bi-dialectal samples, including, for example, Venetian-Italian (Scaltritti, Peressotti & Miozzo, 2017) and Scots-Standard English bi-dialectals (Ross & Melinger, 2016; Kirk, Fiala, Scott-Brown & Kempe 2014).

Various factors have been proposed in order to explain the inconsistency in the findings (see e.g. Bialystok, 2017; de Bruin & Della Salla, 2019; Green & Abutalebi, 2013; Paap, 2019). These include (but are not limited to) the following. (1) The use of small sample sizes. (2) Failure to equate groups on confounding variables (e.g. culture, socioeconomic status, non-verbal fluid intelligence, immigration status). (3) Various aspects related to the tasks used (e.g. the use of verbal or single tasks or the use of tasks that do not show convergent validity). (4) The specific characteristics of bilinguals (e.g. language proficiency level). Finally, some researchers have criticized the fact that many studies lack a clear theory regarding the nature of EC and how bilingualism influences this cognitive system (e.g. Jared, 2015).

Researchers who advocate the existence of a bilingual advantage have proposed different theoretical accounts about the specific cognitive locus of this benefit. Two broad views have emerged. The first view suggests that the bilingual advantage is found in distinct EC components. Bialystok and colleagues (e.g. Bialystok, Craik, Green & Gollan, 2009), for instance, initially proposed that the bilingual advantage is found specifically in inhibition. This early account was based on Green's (1998) model of bilingual language processing according to which the use of the intended language requires the inhibition of the other language. According to the second view, bilingualism has a more general effect on the EC system. Bialystok (2011; 2017), for instance, proposes that the bilingual advantage is rooted in the ability to coordinate or jointly recruit all different EC components or in *executive attention*. Executive attention is a resource-limited, continuous construct that refers to the ability to attend to goal-relevant information and maintain it in an active state under distraction. It becomes attuned in bilinguals because of their continuous experience in resolving competition between two simultaneously active linguistic systems.

To sum, past research has provided some evidence for a bilingual advantage in EC, even though this benefit is not always replicated and some researchers even contest its very existence (e.g. Paap, 2019). Moreover, advocates of the BECA do not agree regarding the specific cognitive locus of the bilingual advantage in EC tasks (e.g. Bialystok et al., 2009; Bialystok, 2017). In addition, past studies have mostly focused on speakers of two clearly distinct languages. There has been relatively little research on bi-dialectals, with the few studies on the topic also reporting mixed findings.

The Present Study

Against this background, the main goal of our study was to examine the effect of multilingualism and bi-dialectalism on EC using an experimental design that carefully takes into consideration various factors that have been proposed in the literature to contribute to the variability in the findings. We aimed to achieve this goal by comparing the EC skills of multilingual, bi-dialectal and monolingual young adults in the sociolinguistic context of Cyprus. The sociolinguistic situation in Cyprus is generally described as diglossic, with Greek Cypriots typically speaking CG and SMG (e.g. Antoniou et al., 2016). CG is natively and naturalistically acquired and is used for everyday communication. SMG, on the other hand, is learnt mainly through formal education, it is the language of schooling, the media and is used for reading, writing and in formal situations. We predicted that bi-dialectals would exhibit a similar EC benefit to that of multilinguals for two reasons. First, because the previous study conducted in Cyprus (with children) showed that both multilinguals and bi-dialectals had superior EC skills relative to monolinguals and did not differ from each other (Antoniou et al., 2016). Second, because there is some evidence that lexical access operates in the same way and that co-activation is similarly present in bilingual speakers of any pair of languages. This includes bilinguals who speak very similar languages or even (at least some) bi-dialectal speakers (see in Kirk, Kempe, Scott-Brown, Philipp & Declerck, 2018).

Moreover, we aimed to test between the two accounts of the locus of the bilingual advantage (if found). Thus, we designed our study (by employing seven EC tasks) and analyzed our data using Miyake et al.'s (2000) model of EC. If bilingualism affects specific components, we expect to find an interaction between the Group and EC factors. On the other hand, if bilingualism has a broader effect on EC, we expect that only the Group factor will be significant.

Method

Participants

Participants included 46 multilinguals (speakers of CG, SMG and another language; 34 female; aged 18–30 years, mean age 21.8, *SD* 3.03 years), 72 bi-dialectals (in CG and SMG; 49 female; aged 18–36 years, mean age 21.5, SD 3.3 years) and 47 monolinguals (speakers of SMG; 37 female; aged 18–38 years, mean age 22.5 months, *SD* 4.02 years). All participants were recruited in Cyprus. Monolingual participants were Greek citizens who lived in Cyprus but originally came from Greece (for work or studies).

Materials and Procedure

Participants were given seven EC tasks, the Matrix reasoning test from the Wechsler Abbreviated Intelligence Scale (WASI; Wechsler, 1999) for non-verbal fluid intelligence and the Mill Hill Vocabulary scale (Raven, Raven, & Court, 2000). They were also asked to complete a Language Background and Socioeconomic Status questionnaire. All tasks and questionnaires were administered in SMG.

We included at least two tasks for each EC component. The Rotation Span task (Foster, Shipstead, Harrison, Hicks, Redick & Engle, 2015), the forward and backward Corsi Blocks task (Mueller & Piper, 2014) and the N-back task (e.g. Jaeggi, Buschkuehl, Perrig & Meier, 2010) were administered as tests tapping into working memory. For inhibition, we used the Flanker (e.g. Fan, McCandliss, Sommer, Raz & Posner, 2002) and Stroop tasks (e.g. Unsworth, Redick, Spillers & Brewer, 2012). Finally, for switching, participants were given the Color-Shape (e.g. Friedman, Miyake, Young, DeFries, Corley & Hewitt, 2008) and Number-letter tasks (e.g. Karayanidis, Jamadar, Ruge, Phillips, Heathcote & Forstmann, 2010).

Participants were tested in two sessions (in random order). One session included the Rotation Span, Corsi Blocks, Color-Shape, Stroop tasks and the WASI test in counterbalanced order. The Mill Hill test was always administered last. In the other session, participants were given the Number-letter, Flanker and N-back tasks, again, in a counterbalanced order.

Socioeconomic Status and Language Background Questionnaire. The questionnaire asked for information regarding the participant's language use in various domains of daily life. It also required information regarding the participant's date of birth, gender, place of birth and level of education (*0*=no degree to *3*=doctoral degree), among other topics. Finally, three scores of the family's socioeconomic status (SES) could be extracted from the questionnaire: the family's wealth (*0*=low affluence to *9*=high affluence) as measured by the Family Affluence Scale **(**FAS; Boyce, Torsheim, Currie & Zambon, 2006) and the parents' levels of education (*0*=no education to *5*=doctoral degree).

The Stroop Task. Participants saw color words in SMG (*BLUE*, *RED*, *GREEN*) or a string of Xs (e.g. *XXXX*) printed in blue, red or green color. They had to respond based on the print color of the stimuli. For congruent trials, the color word was compatible with its font color (e.g. *BLUE* printed in blue color). For incongruent trials, each color word was incompatible with its font color. The neutral condition included trials with a string of Xs. There were two test blocks (presented in random order) with 108 trials each (36 trials per condition).

The Flanker Task. Participants saw a single or a series of five arrows. They had to indicate whether the center arrow pointed to the left or right. For congruent trials, the center arrows pointed to the same direction as the center arrow. For incongruent trials, the center arrow pointed to the opposite direction compared to the flanker arrows. For neutral trials, there was only one arrow. There were three test blocks (in random order) with 96 trials each (32 per trial type).

The Color-Shape Task. Participants saw a cue (letters *Y* or *Z*) for 150ms. While the cue remained on screen, they were then presented with a target triangle or circle in a green or red square. Depending on the cue, participants had to perform either the shape (whether the shape is a triangle or a circle) or the color task (whether color is red or green). In pure blocks, they had to perform either only the color task or only the shape task. In mixed blocks, they had to switch between the two tasks. For repeat trials in mixed blocks, participants had to perform the same task as for the previous trial. For switch trials, they had to switch to the other task compared to the immediately previous trial. There were four test blocks including a pure color block (where participants performed only the color task), a pure shape block (where they had to focus only on the shape task) and two mixed blocks. Test pure blocks included 24 trials each, while test mixed blocks included 24 switch and 23 repeat trials (or the reverse).

Number-letter Task. Participants saw a cue (green, blue, red or orange square) on a black screen for 700ms. While the cue remained on screen, they were presented with a target number-letter pair. Participants were instructed that, depending on the cue, they had to perform either the number (decide whether the number is odd or even) or the letter task (decide whether letter is a vowel or a consonant). In pure blocks, they had to perform either only the letter task or only the number task, while in mixed blocks, they had to switch between the two tasks depending on the cue. Mixed blocks consisted of switch and repeat trials. There were six test blocks (a pure letter, a pure number and four mixed blocks). Test pure blocks included 72 trials each, while test mixed blocks included 35 switch and 36 repeat trials (or the reverse).

N-back Test. Participants saw a sequence of (hard-to-describe) visual stimuli in each block. The stimuli were presented at the center of a black screen one at a time. Depending on the condition (2-back, 3-back, 4-back), participants had to press a button on a game controller if the current stimulus was identical to a stimulus that appeared *n* (2, 3, or 4) positions earlier and a different button if it was not the same. There were 12 test blocks (four for each level). Target trials were those where, depending on the condition (2-back, 3-back, 4-back), the current stimulus matched a stimulus that appeared *n* positions earlier. The test included

72 target trials, 6 within each block. From this task, we used the proportion of correct target trials.

Rotation Span. We used the shortened version of the Rotation Span task, but translated and adapted in SMG. From this test, we used the partial score (see Foster et al., 2015).

Corsi Blocks Task. We used the Corsi blocks task from the Psychology Experiment Building Language (PEBL) Psychological Test Battery (Mueller & Piper, 2014). We took two measures from this task: number of correct responses in the forward and in the backward condition.

Mill Hill Vocabulary Scale. In the Definitions sub-test, participants had to explain the meaning of 44 SMG words. In the Multiple-Choice sub-test, they were given another 44 target SMG words. They had to select the word (among six choices) whose meaning was closer to the target word.

Results

Preliminary Analyses

Confirmatory Factor Analysis. We first conducted a Confirmatory Factor Analysis (CFA) on the EC data (with robust method). For inhibition and switching, we used mean reaction times (RTs) from the incongruent and switch conditions of the relevant tasks instead of the reaction time difference scores (incongruent minus congruent/neutral and switch minus repeat/pure), as measures of the target cognitive skills. We took this decision because the difference scores correlated very weakly with each other and with the other EC measures (e.g. the correlation between the difference scores in the ANT and the Stroop task was r(two-tailed)=.05, p>.05). There was only a significant (albeit small) correlation between the difference scores for the two switching tests (r(two-tailed)=.17, p<.05) and a significant correlation between the Color-Shape difference score and the partial score from the Rotation Span task (r(two-tailed)=-.24, p<.05). In contrast, when considering RTs in incongruent and switch trials, the correlations among the EC measures were higher and (most of them) significant (see Table 1).

The CFA sesults (Figure 1) suggest that the three-factor structure was a good fit to the observed data, $\chi^2(17)=15.96$, $p>.05$, $\chi^2/df = .94$, with the following fit indices: CFI = 1.0, NNFI = 1.0, RMSEA value was 0.00, with a 90% confidence interval of 0.00 to 0.06. All factor loadings were statistically significant and of acceptable magnitude (Hair, Black, Babin & Anderson, 2014: 618). Further, the correlations among the three factors were moderate to large (see Figure 1).

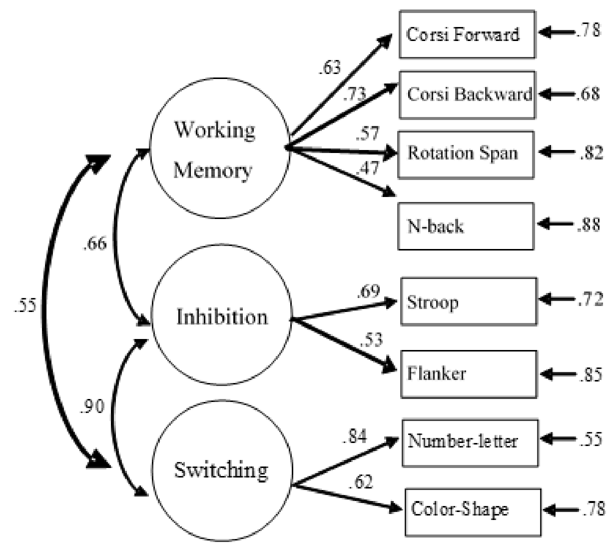

Figure 1. The estimated three-factor model. Numbers next to the large, single-headed arrows represent factor loadings. Numbers at the ends of the smaller arrows are error terms. Numbers next to the double-headed arrows represent correlation coefficients. All paths are statistically significant, p< .001. Paths represent standardized values.

Table 1. Bivariate correlations between the executive control measures used in our study.

	Stroop RT	Flanker RT	NL RT	CS RT	N-back	Corsi For.	Corsi Back.
Flanker RT	.346**						
NL RT	.529**	.370**					
CS RT	.423**	.235**	.526**				
Nback	-.237**	-.144	-.253**	-.196*			
Corsi For	-.279**	-.263**	-.214*	-.254**	.267**		
Corsi Back	-.256**	-.196*	-.264**	-.227**	.333**	.442**	
RS	-.125	-.091	-.257**	-.295**	.261**	.265**	.412**

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Note. RT=reaction times, Stroop RT=RT for incongruent trials in the Stroop task, Flanker RT=RT for incongruent trials in the Flanker Task, NL RT=RT for switch trials in the Number-letter task, CS RT=RT for switch trials in the Color-Shape task, Corsi For.=number of correct trials in the forward Corsi Blocks task, Corsi Back.=number of correct trials in the backward Corsi Blocks task, RS=partial score in the Rotation Span task, N-back=proportion of correct target trials in the N-back test.

Composite Scores. We computed composite scores for each EC factor from the individual variables that loaded on each factor. The composite scores were calculated as follows. For each individual variable, we transformed participants' scores for the entire sample into *z* scores. Then, to calculate the composite score for each EC component, we averaged the relevant (*z* transformed) measures. The Inhibition and Switching composite scores were reversed scored by multiplying with -1, so that a higher score indicated better performance. Composite scores were also created (as above) for background variables that are conceptually related and significantly correlated with each other. Thus, scores in the two sub-tests of the Mill Hill vocabulary test were collapsed into a single score indicating vocabulary proficiency in SMG and levels of maternal and paternal education and FAS score were combined into a single SES composite measure.

Background Variables. Descriptive statistics for education level, SMG Vocabulary, performance in the WASI test and SES by group are presented in Table 2.

Table 2. Descriptive statistics for background variables by language group.

	Educ M (SD)	SES M (SD)	IQ M (SD)	Vocab M(SD)
Mul	1.1 (0.5)	0.03 (0.7)	27.2 (3.5)	-0.5 (1.2)
Bid	1.1 (0.5)	-0.02 (0.8)	28.3 (3)	0.03 (0.6)
Mn	1.2 (0.5)	-0.02 (0.6)	27.3 (4.3)	0.5 (0.6)

Note: Mul=multilinguals, Bid=bi-dialectals, Mn=monolinguals, M=mean, SD=Standard Deviation, Educ=Education level, SES=socioeconomic status composite score, IQ=performance in the WASI test, Vocab=SMG vocabulary composite score.

The groups did not statistically differ in age ($F(2, 161)=1.223$, $p>.05$), gender ($\chi^2(2)=1.7$, $p>.05$), education level ($F(2, 161)=0.842$, $p>.05$), performance in the WASI test ($F(2, 157)=1.7$, $p>.05$) and SES ($F(2, 150)=0.1$, $p>05$).

However, there were significant group differences in terms of vocabulary ($F(2, 162)=18.56$, $p<.05$). Post-hoc tests with Bonferroni correction applied showed that monolinguals had a significantly higher vocabulary than both bi-dialectals and multilinguals; and bi-dialectals had a significantly higher vocabulary than multilinguals (all *p*s<.05). For this reason and because some of our EC tasks involved a verbal component (e.g. judge whether a letter is a consonant or a vowel in the Number-letter task), vocabulary was included as a covariate in the between-group analyses. Given that EC is generally thought to be a domain-general, non-verbal cognitive system, including vocabulary as a covariate would remove error variance from our EC measures resulting in an increase of power to detect potential group differences.

We acknowledge, however, that, since the Group factor and SMG vocabulary are related, the inclusion of SMG vocabulary as a covariate will also adjust (to some degree) for group differences in SMG vocabulary. Analysis of Covariance (ANCOVA) can be legitimately used when the Group factor is not independent from the covariate, at least in some situations. However, some researchers have raised concerns about its use in such contexts (see e.g. in Maxwell, Delaney & Kelly, 2018 for a discussion of ANCOVA in such cases). To address these concerns, in the *Main Analyses* section, we perform a second analysis on a subset of our participants. In this subset, group differences were minimized and groups did not statistically differ in (a measure of) SMG vocabulary (even though numerical differences still existed). We also discuss how the ANCOVA results (with SMG vocabulary as a covariate) can be interpreted (in terms of the multilingual/b-dialectal effect) in the *Discussion* section.

Main Analyses

Descriptive statistics for EC by group are presented in Table 3. An ANCOVA with Group (Multilinguals, Bi-dialectals, Monolinguals) as a between-subjects factor, EC (WM, Inhibition, Switching) as a within-subjects factor and Vocabulary as a covariate showed a significant Group effect ($F(2, 161)=3.39$, $p<.05$) and a non-significant Group by EC interaction ($F(4, 322)=0.815$, $p>.05$)[2]. Planned contrasts showed that both multilinguals (contrast estimate=0.32, $SE=0.15$, $p<.05$) and bi-dialectals (contrast estimate=0.29, $SE=0.12$, $p<.05$) had significantly higher EC scores than monolinguals. The lack of a significant interaction indicates that both the multilingual and bi-dialectal advantage is found in overall EC ability and not in a specific EC component. Vocabulary also had a significant effect on EC ($F(1, 161)=5.3$, $p<.05$) suggesting that, as predicted, our EC measures included verbal, non-EC variance and that the use of ANCOVA was necessary to remove it.

[2] We do not believe that the group differences in sample size affect our results, for various reasons. First, the imbalance was relatively small (the bi-dialectal group was approximately 1.5 times larger than the other groups). Second, the multilingual and monolingual groups were of approximately equal size. Third, for our analyses, we used Type III sums of squares, which is one of the recommended approaches for factorial Analysis of Variance (ANOVA) with unequal sample sizes (Maxwell et al. 2018). Moreover, similar results are abtained when using the Type II sums of squares approach, which is also sometimes recommended (Maxwell et al., 2018). Finally, unequal sample sizes might be problematic in the presence of heterogeneity of variance (Maxwell et al., 2018). For our data, Levene's test indicates that the assumption of homogeneity of variances is met (for WM: $F(2, 162)=0.005$, $p>.05$; for Inhibition ($F(2, 162)=0.119$, $p>.05$; for Switching: $F(2, 162)=2.59$, $p>.05$).

Table 3. Descriptive statistics for each executive control component by language group.

	WM M (SD)	Inhibition M (SD)	Switching M (SD)
Mul	0.08 (0.7)	0.07 (0.8)	-0.06 (1.08)
Bid	0.02 (0.7)	0.06 (0.8)	0.15 (0.8)
Mn	-0.12 (0.7)	-0.16 (0.9)	-0.17 (0.7)

Note: Mul=multilinguals, Bid=bi-dialectals, Mn=monolinguals, M=mean, SD=Standard Deviation, WM=Working Memory composite score, Inhibition=Inhibition composite score, Switching=Switching composite score.

To alleviate any concerns that the significant Group effect might be due to the significant relation between the Group factor and the Vocabulary covariate, additional analyses were conducted. Specifically, for each of the multilingual and the bi-dialectal groups, we retained only those participants who had a higher Vocabulary score than their respective group's mean. This way, we retained 31 multilinguals and 36 bi-dialectals. The resulting groups did not statistically differ in age (F(2, 110)=0.45, p>.05), gender ($\chi^2(2) = 2.22$, p>.05), education level (F(2, 110)=0.86, p>.05), performance in the WASI matrix reasoning test (F(2, 107)=2.58, p>.05), SES (F(2, 102)=0.58, p>.05) and in the Definitions sub-test of the Mill Hill test (F(2, 111)=2.53, p>.05), even though they were still different in the Multiple Choice Mill-Hill sub-test (F(2, 110)=4.56, p>.05) and in overall SMG vocabulary (F(2, 111)=4.36, p<.05). Using Mill-Hill Definitions as a covariate, a mixed ANCOVA with Group as a between-subjects factor and EC as a within-subjects factor revealed, again, a significant Group effect (F(2, 110)=3.6, p<.05) and a non-significant Group by EC interaction (F(4, 220)=0.49, p>.05). The Group effect was due to both the multilingual (contrast estimate=0.35, SE=0.15, p<.05) and the bi-dialectal (contrast estimate=0.29, SE=0.14, p<.05) group having significantly higher EC scores than monolinguals.

Discussion

In this study, we examined the effect of multilingualism and bi-dialectalism on EC. We started with the three-factor theoretical framework of EC proposed by Miyake et al. (2000) and each component was measured through multiple tasks. Results indicated that Miyake et al.'s (2000) model was a good fit to our EC data. Our study was also designed to test between two accounts regarding the cognitive locus of the multilingual and/or bi-dialectal advantage: first, that the advantage is found in specific EC components (e.g. Bialystok et al., 2009) and, second, that bilingualism has a more general effect on the whole EC system (e.g. Bialystok, 2017).

The results of our study revealed two main findings. First, multilinguals and bi-dialectals exhibited significantly higher EC scores than monolinguals. The differences were found using ANCOVA with SMG vocabulary as a covariate. While the use of ANCOVA increases power by removing error (e.g. non-EC, language) variance from the dependent measure, it also stastically adjusts (at least to some degree) for group differences in the covariate (Maxwell et al., 2018). This suggests that the EC benefit in our sample is possibly restricted to multilinguals and bi-dialectals with a high level of SMG proficiency. Second, both the multilingual and the bi-dialectal advantage was found in overall EC ability and could not be attributed to a specific EC component. Crucially, both findings are in line with the results of the study conducted by Antoniou et al. (2016) in the same context (Cyprus) but with young children.

Moreover, the group differences cannot be attributed to a range of potential confounding factors. Our groups did not differ in terms of age, gender, education level, non-verbal fluid intelligence or socioeconomic status. We also believe that culture and immigration status cannot confound our results. First, cultural differences in EC have been reported for broader cultural groups such as Asian and Western/American participants (e.g. Sabbagh, Xu, Carlson, Moses & Lee, 2006). Crucially, none of our multilinguals spoke a language that indicated an Asian background. In addition, Greek Cypriots and Greeks differ minimally in terms of culture (e.g. Cyprus and Greece have strong historical ties, they are in very close geographic proximity, share the same religion, they are both members of the European Union). Finally, most participants in our sample who might be considered immigrants (e.g. study or work in a foreign country) belonged to the monolingual group. This suggests that the multilingual/bi-dialectal effect in our study cannot be explained by immigration status given that it is immigrants who are often reported to exhibit better outcomes in cognitive or other aspects (e.g. Paap, 2019).

Overall, our results suggest that multilinguals enjoy an EC advantage and that this benefit extends even to bi-dialectal speakers. Moreover, the findings of this study provide support to theoretical accounts which suggest that bilingualism does not affect specific EC processes, but has a broader effect across the EC network (e.g. Bialystok, 2017).

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