Πανεπιστήμιο Κύπρου
Σχολή Μεταπτυχιακών Σπουδών

ΤΜΗΜΑ: ΨΥΧΟΛΟΓΙΑΣ

ΤΙΤΛΟΣ: Investigation of the Multilingual and Bi-dialectal advantage in Executive Control.

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ΜΑΙΟΣ , 2021

Abstract

Μελέτες έδειξαν τα γνωστικά πλεονεκτήματα της διγλωσσίας στις εκτελεστικές λειτουργίες (ΕΛ) της προσοχής, κυρίως στην προσχολική ηλικία και σε νεαρό ενήλικο πληθυσμό. Η παρούσα έρευνα αναλύει παράγοντες τυπολογικών διαφορών μεταξύ δυο κοινών γλωσσών και κατά πόσον η εύρεση πιθανών πλεονεκτημάτων είναι δυνατόν να παραμένουν ενεργά ακόμη και σε μεγαλύτερες ηλικίες. Στην παρούσα μελέτη εστιάσαμε σε ένα υγιή πληθυσμό που μιλάει τη Ρωσική γλώσσα, την Νεοελληνική και την Ελληνο-ποντιακή διάλεκτο, δύο στενές παραλλαγές της ελληνικής γλώσσας που διαφέρουν από άποψη κληρονομιάς, λεξιλογίου και της προφοράς. Η μελέτη επικεντρώθηκε στις διαφορές των επιδόσεων σε διάφορα στοιχεία των εκτελεστικών λειτουργιών, βάση δυο διαφορετικών αναλύσεων. Με την πρώτη να διερεύνα τις γνωστικές διαφορές μεταξύ των ελληνόφωνων μονόγλωσσων νεαρής ηλικίας και των πολύγλωσσων μεγαλύτερης ηλικίας ομιλούντες της νεοελληνικής και Ελληνοποντιακής διαλέκτου. Έγινε σύγκριση των επιδόσεων, βασιζόμενοι στην χρήση αρκετών έργων ικανά να συλλέξουν πληροφορίες σχετικά με τη ΕΛ κυρίως των λειτουργιών της αναστολής πληροφοριών , της μνήμης εργασίας και την εναλλαγή ερεθισμάτων της προσοχής. Η ανάλυση αποκάλυψε ότι η ομάδα των πολύγλωσσων υπερέβηκε σε επιδόσεις των ΕΛ σε σύγκριση με την ομάδα των μονόγλωσσων, με σημαντικές διαφορές κυρίως στα έργα της μνήμης εργασίας, υπέρ των πολύγλωσσων. Στην δεύτερη ανάλυση επικεντρωθήκαμε κυρίως στις διαφορές μεταξύ νέων και μεγαλύτερων ηλικιακών ομάδων της ποντιακής-ελληνικής διάλεκτού, δείχνοντας ότι η πολυγλωσσία και η γνώση διαλεκτικού αποτελούν σημαντικούς παράγοντες για την πρόληψη των γνωστικών αλλοιώσεων που σχετίζονται με την ηλικία.

Several studies investigated the cognitive advantages of bilingualism on executive control (EC), where most of them is mainly focused on preschool or young adult population. We investigate two issues that are mainly undiscovered, the role of typological differences between the languages spoken by multilingual and whether those advantages remain active even on older ages. In the present study we focused on old age healthy population who speaks Russian language , Modern Greek, and Greek-Pontic dialects , two closely diversions of Greek Language which differ in terms of heritage, vocabulary, and pronunciation. The study focused on the performance differences on several EC components based on two analyses. The first investigated the cognitive differences between young age Greek speaking monolinguals and old age multilingual who also speaks Modern Greek and Greek Pontic dialects. We compared their performances with the use of several EC task on Inhibition, Working Memory and Switching components of attentions. The analysis revealed that multilinguals outperformed on EC compared to monolinguals, with significant differences on Working Memory components in favor of multilingual group. The second analysis focus on the differences between young and older age groups of Pontic-Greek dialect on EC performances, showing that multilingualism and dialectism are important factors for the prevention of age-related cognitive declines.

Introduction

Studies on bilingualism revealed negative effects on aspects of language acquisition compared to positive effects on non-verbal cognitive functioning as attention and more specific on executive control of attention (Adescope et al., 2010). Neuroimaging (Corbetta et al., 2000; Kastner et al., 1999) and cellular recording studies (Desimone and Duncan, 1995) conducted for the investigation of brain and biological origins of attention. In their findings, they presented that attention is orienting though sensitivity, with the activation of specific neural networks before the presentation of the stimuli. Suggesting that attentional system is connecting with neural activations, responsible for the target processing inhibited the same time the cognitive attentional system.

In respect to the above, behavioral, and neuroscientific studies found that the attention system is divided by three main systems, anatomically independent from each other (Fan et al., 2005; Fan et al., 2002; Posner and Petersen, 1990; Posner and Rothbart, 2007). The alerting network who is responsible of the alert state and its inhibition, the orienting network is responsible for the sensory attention through space and the executive control is responsible for the resolution conflict of stimulus and response. It has been recommended that the alerting and situating systems might play contradicting parts in recruiting attention. The alerting system is boosts drive and empowers worldwide consideration. In differentiate, the spatial orienting system measured within the Insect test is objective driven and capable for specifically arranging consideration to a certain limited area. Since these two capacities cannot be activated simultaneously; one might get to switch off one framework when working the other.

In a biological premise, alerting attention is related with thalamic actuation at parietal and frontal cortices able to alarm a reaction (Tracy et al., 2000). The orienting network is hindered through the frontal eye areas (Wardak et al., 2006), through the prevalent parietal projection and the temporal-parietal intersection (Fuentes and Campoy,2008). Whereas other studies uncovered actuations through the prevalent colliculus and the pulvinar nucleus of the thalamus (Shipp, 2004). The executive control network is succeeding with the actuation of the top-down control network related with activations in average ventral prefrontal cortex and the horizontal prefrontal cortex official organize (Bush et al., 2000; MacDonald et al., 2000).

Several research studies support that the regular use of two or more languages enhance several cognitive abilities (Bialystok et al., 2004; Bialystok, Craik and Luk, 2008; Costa et al., 2008). Known as bilingual executive control advantage (BECA), this theory supports the notion that when a bilingual speaker uses one of the languages, the other one remains active, influencing a specific neurocognitive system, the executive control function (Kroll, Dussias, Bogulski & Kroff, 2012). Accordingly, the achievement of this cognitive ability is achieving through the EC, which leads the chosen language into production, preventing the same time any interruptions from the other language. According to

Bialystok (2017), the constant use of these mechanism resolves to better performances of EC skills in several non-verbal tasks. Bilingual advantage in EC performance is mainly observed during the first years in infancy (Kováks and Mehler, 2009), in preschoolers (Yang, Yang and Lust, 2011) and in early years of school children (de Andreu et al., 2012).

Moreover, early studies on EC supports that is mainly succeeded through three different cognitive functions, not entirely unrelated (Miyake et, al., 2000). Respectfully this theory highlights that EC is achieved through shifting or task-switching (a processing that allows us to switch from one task to another), the updating and monitoring the contents of working memory (a processing that allows the successful retrieval of information from the working memory, while allows us to revise it when it is no longer available) and inhibition (a processing that allows us to inhibit main responses and non-dominant information).

Throughout scholar, BECA is mostly observed and analyzed in children's first years, even during infancy (Kovacs and Mehler ,2009), preschool aged children (Calson & Meltzoff, 2008), as well as school age children (de Abreu et. Al., 2012). Hence, studies revealed that this superior advantage is not only observed during infancy, but it remains persisted even at early and late adulthood (Bialystok, Vraik and Freedman, 2007). Studies on young adults' multilinguals showed an advance in selective attention tasks compared to monolinguals highlighting the theory that multilingualism contributes positively to attention performances (VegaMendoza et al., 2015). In contrast, this cognitive advantage is also observed not only on early and late age bilinguals but also within popularities with different levels of explosion to the second language L2 (not the Mother language L1) and different language proficiency (Bak, Vega-Mendoza and Sorace, 2014). Those findings are mostly dependent on several cognitive task as Simon effect (Simon,1969) where participants had to use their inhibitory control and switching functions for its completion (e. g. Bialystok, Martin and Viswanathan, 2005), the Attentional Network task, which is able to measure attention networks, within one task (e.g. Yang et. Al., 2011), or even more classic procedures as the Stroop task (e.g. Poulin-Dubois, Blaye, Coutya and Bialystok, 2001).

However, even though the BECA is broadly accepted, many researchers failed to replicate this advantage, suggesting a non-existence of it (Paap, 2019). It is also controversial, whether the BECA is achieved with the use of all EC components or not. Where earlier studies supported that BECA is achieved through inhibition processes (Bailystok et al., 2009), profoundly influenced by Green's (1998) model of bilingualism, suggesting that the successful retrieval of each language is based on inhibition processes. Further research made by Bailystok (2011;2017), revised their original hypothesis suggesting that the BECA is succeeded through the successful coordination of all EC components or in executive attention. While findings highlight differences between early young bilinguals and late bilinguals, claiming that early bilinguals succeed better on attention-switching

tasks compared to late childhood and late adulthood bilinguals which in respect outperformed on selective attention tasks. Their explanation was that since early bilinguals have more exposure to each language, they developed more advanced switching abilities compared to the other age groups, which trained their inhibitory control since they had to consciously ignore their first language when they performed the second (Sorace, 2016).

Primer studies on bilingualism, also reported a significant advantage of EC not only on typologically different languages as English and Chinese, but also in similar typological languages as English and French (Adescope et al., 2010). Concluding, that any language combination can infer cognitive advantages, despite their typological backgrounds. In the scope of those findings, research also reported that the EC advantage is succeeded through similar languages as dialect (Garbin et al., 2010; Hernandez, Costa, Fuentes, Vivas and Sebastian-Galles, 2010; Hernandez, Martin, Barcelo and Costa ,2013). The studies investigated the EC a bilingual group of Spanish-Catalan speakers and a monolingual group of Spanish speakers. As expected, the bilingual-dialectal group outperformed compared to monolingual on EC tasks, providing evidence that the BECA is also observed after the acquisition of similar languages.

In addition to the above, dialects are considered as varieties of a standard language, which most of the time been heritage by family or society members. The term Heritage language is mostly used for the description of the primer language which young bilinguals been exposed and grew up with usually at home, before their introduction to the formal language of their society which usually learned at school environments (Valdes,2000; Polinsky and Kagan 2007). Heritage language speakers are usually members of immigrated families which have been immigrated to another country, usually for socioeconomic reasons. The expression of "Greek language" includes the standard, Standard Modern Greek (SMG), and all the diverse Greek dialects, for example, Pontic, Cretan and Cypriot Greek (Horrocks, 1997). According to Wardhaugh's (1992) explanation the term language refers to a single norm, with standardized characteristics, whereas the term dialect is a substitution of those characteristics. In any case, regardless of whether one of these language structures is viewed as the norm or authority language of a district, at a given time, is reliant upon financial, political, and recorded conditions as opposed on simply etymological records (Pavlou and Christodoulou, 2001).

Few studies conducted on Greek bidialectalism and how it effects the EC functions. However, two of them is mainly interested to our study conducted by Antoniou, Grohmann, Kambanaros and Katsos (2016), of Cypriot -Greek bidialectalism. The aim of the study was to investigate whether speaking typologically closed languages (Cypriot-Greek and Standard Modern Greek) rise the executive function advantage. The recruited participants were bilectal children of Cypriot Greek and Modern Greek language or multilinguals and bilectal children at school age, compared to monolingual children, who only spoke Modern Greek. The hypothesis was based on Miyakes's (2000) Model of

EC components, and the executive functions measured through a series of tasks. The analysis revealed that the multilinguals performed better on EC tasks compared to monolinguals. The bilectal group also scored better compared to monolinguals and did not differed from the multilinguals, consistently to previous research. The final analysis showed an overall EC system, rather than specific EC components after the exclusion of language proficiency factors.

A more recent study investigated whether the bilingualism itself affects the EC system as a whole or its specific components (Antoniou and Spanoudis, 2020). Once again, the study conducted on Greek-Cypriot language, comparing bilectals, multilinguals and monolingual speakers of Modern Greek Language. The group were young adults who lived or study in Cypriot region. Once again, the analysis performed based on Miyake's (2000) model of EC components, while the data measured working memory, inhibition and switching processes. The design of the study was consisted with Antoniou et al. (2016), with the difference that the main interest was on bi-dialectal population (Cypriot-Greek and Modern Greek) speakers, as their previous study showed evidence of dialectal advantage on EC performances. The final analysis revealed that multilinguals and bi-dialectals performed better on EC compared to monolinguals and no advantages on specific EC components observed.

Since, this study focused on older age population supports the evidence of better performance on EC even in bigger ages and on similar typologically languages. Pontic-Greek is also a heritage language as it is used only by Pontiac minorities which emigrated from Pontiac region to the mainland of Greece or other European countries as Russia and the shores of black sea or Caucasus (Bruneau,2013). Hence, one of the two languages can be easily characterized as an ethnolinguistically minor language, used mainly between Pontiac society, whereas the other language is major used in a broader social domain (Montrul, 2010).

It is a typical reality that the bilingual mind is analyses out uniquely in contrast to a monolingual one, since the nearness of two dialects influences the neural systems that are liable for both language preparing and intellectual working (Bialystok, Craik, Luk, 2012). That is why studies focused on older people as them cognitive capacities minimized during aging and evaluated the contribution of bilingualism in them cognitive abilities as they mature, known as age related cognitive declines , which also influence the EC (Bialystok, Craik, Klein, Viswanathan, 2004). Supporting that the knowledge of two or more language is possible to protect those abilities, as BECA is also persistent even in older ages (Alladi et al ., 2013).

The present study

In the present study recruited two different age and typological groups, young age monolinguals who born at Greece region and speaks Greek and an older age group of multilinguals and bi-dialectals of Russian Language , Modern Greek, and Pontic Greek. Both groups administered in a battery of EC

tasks, which been proposed in the literature as necessary variables for the investigation of EC. We intent to achieve this by comparing their responses not only on specific components of the EC (inhibition, switching and working memory), but also on their overall performances EC by composite all the three factors. The Pontic Greek language is mainly heritage and used in home settings or between the Pontic communities. The interesting difference in our study, is that our multilingual group is emigrated from Russia and Georgia countries where been educated in Russian language, however their knowledge of Modern Greek acquired after their return to Greece and final move to Cyprus region in young age, compared to other research where their multilingual groups learned Greek language as their first Language (Antoniou et al., 2016; Antoniou and Spanoudis, 2020).

We predict that multilinguals will exhibit advanced performances on EC, based on BECA theory (Bialystok et al., 2004; Bialystok, Craik and Luk, 2008; Costa et al., 2008). Accordingly, as our groups differ in language acquisition, we believe that the knowledge Pontic Group will perform better on EC compared to monolinguals as previous studies found the knowledges of the two similar languages can also contribute to advanced performances on EC (Kirk et al, 2018; Antoniou and Spanoudis, 2020). We also hypothesize that a comparison between young and old age group of bi-dialectal will also show no differences in their performances as studies found that BECA is possible to remain active even on older ages (Bialystok et al., 2004). In total, we aimed to test whether the knowledge of two similar language been related with advanced EC performances, as well as a preventing factor for age-related cognitive decline as it is expected to find non-significant differences in the performances of the two age and language groups.

Method

Participants

Participants consisted of 32 young age monolinguals(speakers of SMG; aged 18-38 years, mean age 22) and 30 multilinguals (speakers of RL, MG and PG; aged 37-69, mean age 50). The older adults' group of multilinguals and bi-dialectal Pontiac- Greek, and younger adults Greek Monolinguals which will be used as control group. The older adults' group recruited into two separate age sub-groups younger and older with the use of median analysis. They are Greek emigrates who were born in Russia or in the origin of Pontous (Now is north Georgia and Turkey). Their native language is Russian, and their dialects are Pontic and Modern Greek. The participants recruited from public Pontic-Greek local clubs in the region of Cyprus. The monolingual group were Greek citizens , undergraduate students at Cyprus University, born in Greece. As their linguistic knowledge was only on Greek language, no background information measured regards to their exposure on the MG, compared to the multilingual group where the addition of Background information's was necessary for the investigation of language and emigration statues.

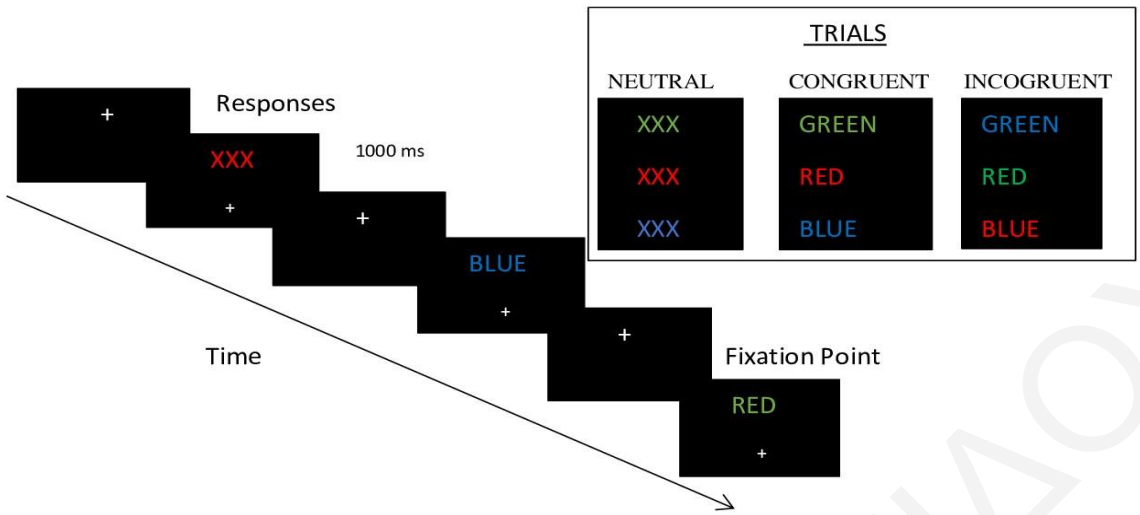
Materials and Procedure. The experimental materials consisted of six EC tasks and a Matrix reasoning test from the Wechsler Abbreviated Intelligence Scale (WASI; Wechsler, 1999) suitable for the measurement of non-verbal intelligence. A Language Background Questionnaire was given prior to all the experimental procedures. All tasks were administered in Modern Greek language and were included two tasks for each EC component. For the investigation of inhibition participants asked to complete a Stroop task (Unsworth et al., 2012), and the Flanker Task (Fan et al., 2002). Data for the switching component measured with the use of the Color-Shape Task (Friedman et al., 2008) and Number-Letter task (Karyanidis et al., 2010). The Corsi Blocks task (Mueller & Piper, 2014) and the Rotation Span test (Foster et al., 2015) were administered for the working memory component. All the experimental procedures were counterbalanced to minimise any order effects.

Language Background. The questionnaire requested basic information of participant's date of birth, gender, and level of education ranked from 1 (high school education) to 3 (Master education). The language component was measured through a series of questions regarding the use of language in everyday elements, as well as level of knowledge of each language. Also, the place of birth, as well as current living place were considered as emigration references. The age of language onset and language acquisition is also measured for the investigation of language proficiency. The background information questionnaire was given only to the Pontic-Greek group as no data information's were necessary for the monolingual group.

The Stroop task. In the Stroop task condition participants asked to respond as quickly and accurate based on printed colour words (BLUE, GREEN, RED) in SMG or a string of coloured Xs (e.g.XXXX), presented in their screen (see Figure 1). The task was accompanied by congruent trials where words congruous by the colour (e.g Blue printed in blue colour). While, for the incongruent condition were words incongruous by the colour (e.g Blue printed in Green Colour). The String of coloured Xs was used as neutral condition. In total, two test blocks were presented on the screen with 108 trials in each one (36 per condition).

Figure 1

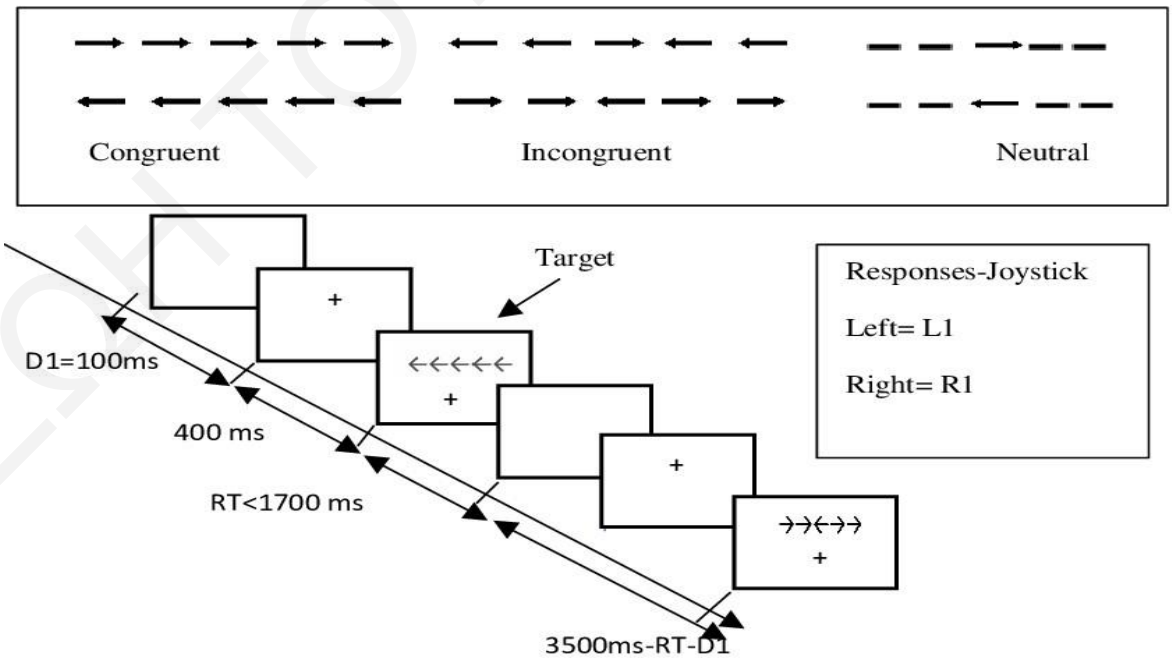
Representation of the Stroop task used in the study.



The Flanker Task. In the Flanker task a series of a single or five arrows were presented on the screen pointed either right or left. Participants were instructed to respond whether the centre arrow is pointed left or right. The task contained a congruent and incongruent target condition as well as neural trials with the presentation of a single arrow. There were three test blocks in randomised order with 96 stimuli in each trial (see Figure 2). The participants responses measured with the use of joystick were participants asked to respond as quickly and accurate they can by pressing either the R1 button for the right responses or the L1 for the left. The order of the cues where counterbalanced for the equal presentation of task conditions.

Figure 2

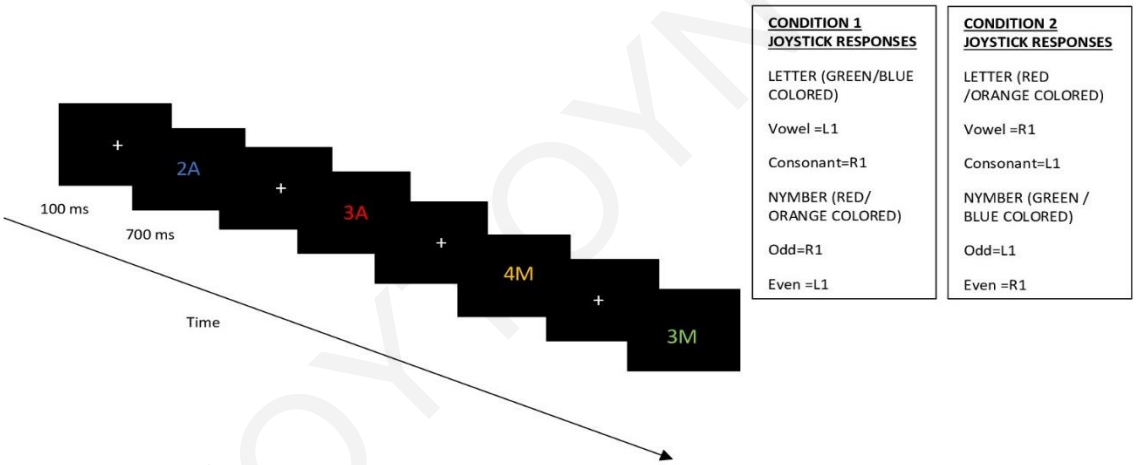
Representation of Flanker task used in the study.



The Number-letter task. At the Number-letter task a black screen with coloured cues (green, blue, red or orange square) were presented to the participants, accompanied with targets of number-letter pairs for approximately 700 ms. Participants instructed to respond, depending to the cue, whether the presented number is odd (2, 4, 6) or even (1,3,7) or whether the letter task is a vowel (A, E, I) or consonant (K, Λ ,M). The instructions and the letter representation were adapted on Greek language. Participants asked to respond in two target conditions, the pure blocks, where only the letter task or the number is presented on the screen, and the mixed blocks where both tasks will be switched and repeated (see Figure 3). In total, used six test blocks of a pure letter, a pure number and four mixed blocks in the study, for both conditions. 72 trials presented for the pure blocks, 35 switch and 37 repeated trials for the mixed blocks. The responses performed with the use of a joystick, based on given instructions.

Figure 3

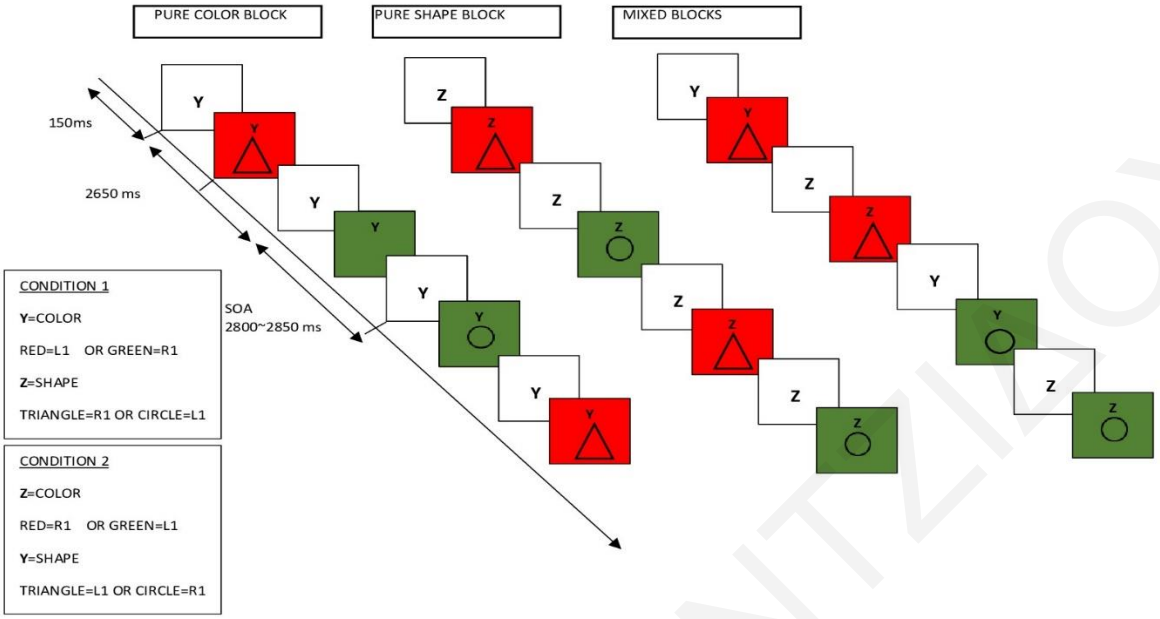
Representation of number letter task used in the study.



The Color- Shape Task. At the Color-Shape Task a cue presented to the participants (letter Y or X) for approximately 150ms. The presentation of the cue followed by a target triangle or circle in green or red square. Participants asked to response as quickly and accurate either the shape of the target (triangle or circle) or the color of it (red or green) based on the given instructions. The task accompanied by four test blocks of pure color, were participants had to respond only the color of the target, the pure shape block, where they had to respond on the shape of the target and two mixed blocks where they had to switch between the previous two blocks. In total, each pure block contained 24 trials, while the test mixed blocks had 24 switched targets and 23 repeated. The test mixed blocks had been also reversed during the experimental procedures, representations of the task are given in Figure 4.

Figure 4

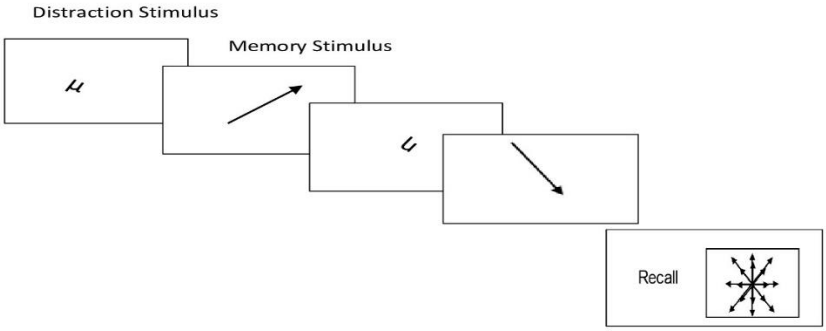
Color shape task representations and times of cue appearances.



Working Memory Components. For the working memory components, the Rotation Span test was translated and adjusted into SMG. Participants are shown a series of arrows in various orientations (0-315 in 45 degree jumps) that are either long or short (also big or small since long arrows are thicker). The participants must remember the arrows were displayed in the correct serial order. Following each arrow, participants are given a processing task in which they are shown a letter (μ, η,ι ,β) that is either in its normal representation or a mirror image. It can also be rotated at one of the 45-degree angles. As a result, the task is to determine whether the letter is normal or mirror, and to do so, participants must mentally rotate the picture. Participants instructed to respond whether the letter is correct or a mirror image and after a series of representations stimulus finally to recall the correct appearance of the arrows (see Figure 5).

Figure 5

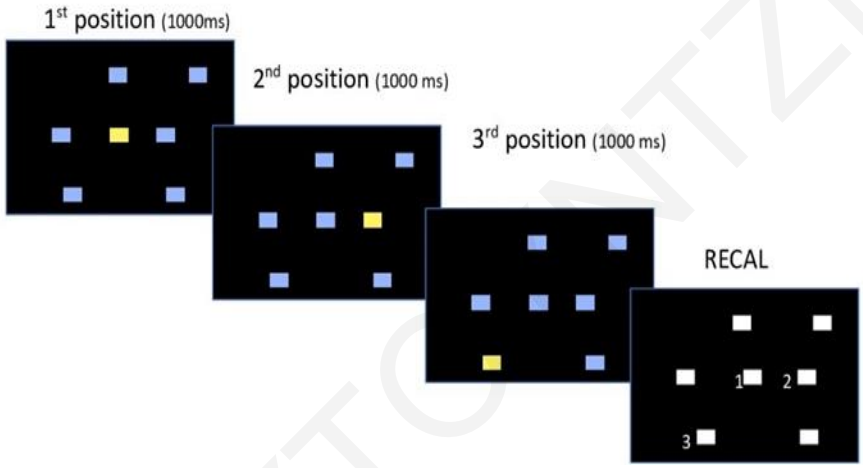
Representation of the adapted Rotation Span test



While for the Corsi Block task the number of participants' correct responses in forward conditions used in the final analyses. The measurement of Corsi Block task achieved with the use of Psychology Experiment Building Language (PEBL) Psychology Test Battery. Corsi Block is suitable for the measurement of visual-spatial working memory components as participants instructed on tapping a sequence of blocks of increasing span length in a forward or backward manner (see Figure 6)

Figure 6

Representation of Corsi-block task in forward condition



Results

Preliminary Analysis

For the analysis of inhibition and switching components, used the mean reaction times from the incongruent and switch conditions of the relevant tasks, consistent with previous studies (Antoniou and Spanoudis, 2020). However, the stoop and the Foster task were discarded from the final analysis due to low accuracy measures. All the data transformed into standardized values (z scores) and reversed by multiplied with (-1), to represent better performance on higher scores. The Switching component and the overall EC performance extracted with the use of composite score methods, by average the interested measures. For the age difference analyses of bi-dialectal group was used the median split method. Composite scores also created for the Language Proficiency levels based on participants answers on Language Background Information, instead of a Vocabulary test administration.

The EC components of inhibition and switching extracted with the use of mean reaction times of the incongruent and switch conditions rather than the reaction time difference scores (incongruent minus congruent/neutral or switch minus repeat/pure. This decision been taken as the difference scores measures were correlated very weekly and were non-significant, with the other EC measures. As opposed to, measures of Incongruent and Switch trails' RT's, where their correlations were most of them significant, apart from Number letter and Corsi task with r =-.092, p=.478, two-tailed and the Color-Shape and Corsi Task correlation where almost reached significance with r=-.246, p=.054 (see Table 1).

Table 1.

Bivariate Correlations between the executive control measures used in the study.

Variables	Corsi	Flanker RT	CS RT	NL RT
Corsi	-			
Flanker RT	-.380*	-		
CS RT	-.246	.521**	-	
NL RT	-.092	.677**	.373*	-

**. Correlation is significant at the 0.01 level (two-tailed). *. Correlation is significant at the 0.05 level (two-tailed). Note. RT=reaction times, Corsi = number of the correct trials of Corsi Task, Flanker RT =The reaction times of the incongruent trials of Flanker task, CS RT= The reaction times of the switch trials of Color-Shape Task, NL RT= The reaction times of the switch trials of Number-Letter Task.

Main Analyses

Background measures

In the following analysis will be presented the performance of 30 Bi-dialectals (19 women and 11 men; ages 37-69, mean age 50, SD 35-70).The groups of Bi-dialectals did not significantly differ in education (F (1,28)=2.178, p>.05), language acquisition (F (1,28)=2.882, p>.05). However, there were significant differences in their performances on WASI test with F (1,28)=11.821,p=.002, two-tailed, where the Younger group (M=29.357, SD=2.023) performed higher compared to older (M=26.875, SD=1.928), possible due to age differences. The descriptive statistics of all the above variables (education, language acquisition and WASI test) of the Bi-dialectal group is presented in Table 2.

Table 2

Descriptive Statistics for background Variable (raw scores) by Age Group of Bi-dialectal.

Group	n	Education		IQ		Language	
		M	(SD)	M	(SD)	M	(SD)
Younger	14	1.929	(.512)	26.875	(2.023)	3.524	.339
Older	16	1.563	(.829)	26.875	(1.928)	3.292	.401

Note. n= number of participants, SD= Standard Deviation, Education=The education levels (1 to 3 scale), IQ=score in the WASI matrix reasoning test, Language= The composite (raw scores) of the language proficiency background information questionnaire.

Table 3, reports background information's regards to the years of onset exposure to each language and when the Language Acquisition finally occurred in the two bi-dialectal groups. Based on the data and the other background information that been collected the Pontian language seemed to be learned as their first language introduced at home, whereas the Russian language followed at school and common public environments. The exposure and final language acquisition occurred after their return to Greece.

Table 3

Descriptive statistics for Language Acquisition and Exposure (raw data).

	n		YAG	GLA	RLA	PLA	ECG	ECR	ECP
Younger	14	M	14.143	14.143	3.571	1.786	14.143	2.286	1.357
		(SD	(4.111)	(4.111)	(1.742)	(1.805)	(4.111)	(1.204)	(1.336)
Older	16	M	29.063	29.063	4.938	1.000	29.063	3.250	1.000
		(SD)	(8.598)	(8.598)	(1.237)	(.000)	(8.598)	(1.336)	(.000)

Note. n=number of participants in its group, M=mean, SD= standard deviation, YAG=Year of Arrival in Greece, GLA=Common Greek Language Acquisition (age of onset in years), RLA=Russian Language Acquisition (age of onset in years),PLA= Pontian Language Acquisition (age of onset in years), ECG=Exposure to Common Greek Language (age of onset in years), ECR=Exposure to Russian=Exposure to Russian Language (age of onset in years), ECP=Exposure to Pontian Language (age of onset in years).

As there were not any Vocabulary measures in the present study the Language Proficiency levels measured with the use of the Background questionnaire. Where participants asked to identify from a scale of (0, no Proficiency to 4, very good proficiency levels) of each language and dialect, as well as how confident they feel to use each language. Their data encoded to zero for no confidence to 1 , for absolute use of all languages and dialects. Descriptive statistics of their answers are given at table 4.

Table 4

Descriptive statistic of balance exposure between the three languages and language Proficiency measures (raw data), based on the Language background questionnaire.

Group	n	BE CG R P		LP R		LP CG		LP P	
		M	(SD)	M	(SD)	M	(SD)	M	(SD)
Younger	14	.786	(.426)	4.000	(.000)	3.357	(.633)	3.214	(.699)
Older	16	.750	(.447)	3.750	(.447)	2.750	(.577)	3.375	(.806)

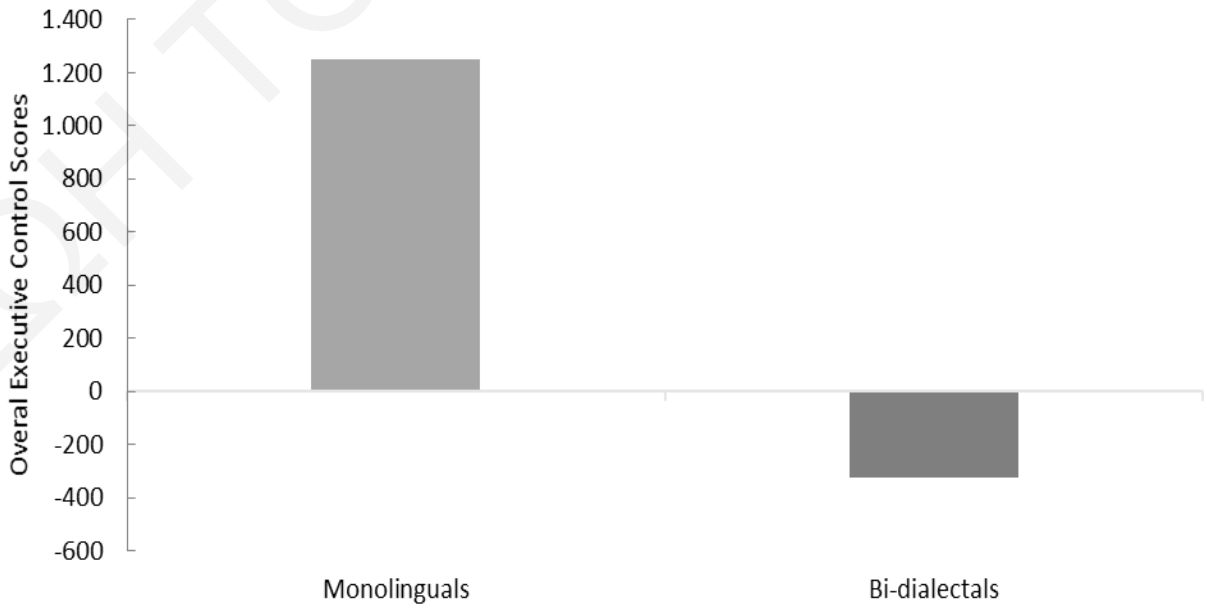
Notes. n= Number of participants, M=Mean, SD= Standard Deviation, BE CG R P= Balance exposure between Russian language, Common Greek, Pontiac dialect (scale 0-1), LPR=Language Proficiency of Russian Language (scale 0-4), LP CG= Language Proficiency of Common Greek Language (scale 0-4), LP P=Language Proficiency of Pontiac dialect (scale 0-4).

Executive control measures between Monolinguals and Bi-dialectals.

An ANOVA analysis was conducted with overall EC composite performances as within-subject factor and Group as between-subjects factor. The effect of Group was not significant with F (1, 60) =.220, p=.640. A graph representation of the mean response times of the two groups is presented in graph 1. A further analysis of independent samples t-test was necessary for any response difference between the groups Inhibition, Switching, Working Memory performances. Representation of the overall performances of both groups in EC is given in Figure 7.

Figure 7

Score performances of the two Groups at overall EC performances.



Most of the T-test showed non-significant differences between the two groups, except working memory, probable due to age differences. The performance of a t-test between Group and Inhibition was t (60) =-538, p=.001, two-tailed. The bi-dialectals scored faster at inhibition components (M=-2.307, SD= 4.737), compared to monolinguals (M=3.064, SD=54.495. The non-significant differences in Switching components were t (60) =-.698, p=.488, bi-dialectal group (M=.359, SD=.175), scored faster compared to monolinguals (M=-.175, SD=1.356). In contrast, significant differences observed after the analysis of Working Memory and Group differences with t (60) =2.481, p=.016, two-tailed. Bi-dialectals (M=1.697, SD=1.457), attained lower scores compared to monolinguals (M=-.862, SD=1.188). Non-significant Group differences observed in overall EC components performances with t (60) =-.469, p=.640, two-tailed. Where, Bi-dialectal outperformed (M=-323, SD=1.485), compared to Monolinguals (M=1.250, SD=18.293). T-test analysis is also presented in table 5.

Table 5

Mean score differences of the two groups at EC components.

Variables	Monolinguals (n=32)		Bilinguals (n=30)		t (60)	p
	M	SD	M	SD		
WM	.862	1.188	1.697	1.457	2.481	.016*
IC	3.064	54.494	-2.307	4.737	-.538	.593
SC	-.175	1.356	-.359	.523	-.698	.488

*. Levene's test is significant at the 0.05 level, (two-tailed). Note. WM=Working Memory components, IC=Inhibition Components, SC=Switching Components.

Executive control analysis for older and Younger Bi-dialectals. An ANOVA analysis conducted for the investigation of the second hypothesis that Bi-dialectism has a positive effect on Executive Control performances even on older ages. The Group analysis between Younger and Older Bi-dialectal population shown non-significant differences between them, supporting our main hypothesis with F (1,28) = 1.293, p=.264, two-tailed. In overall, the two age groups performed almost the same with (M =.005, SD=.1.373), for the Younger and Older age Group (M=-.610, SD=1.563).

T-test analysis also conducted for the investigation of any group differences among the three main measures (Working memory, Inhibition, Switching). The analysis between the two age groups was non-significant, indicating that both groups had no differences in their performances of EC components. The two groups performed almost the same on Working Memory with (M=1.768, SD=.894) for the older group, compared to Younger (M=1.616, SD=1.950), with t (28) =.280, p=.782, two-tailed. Older age group outperformed on Inhibition, (M=-1.198, SD=4.610), compared to younger (M=-3.277, SD=4.776) with t (28) =-1.209, p=.237, two-tailed. In comparison, the two groups performed almost the same at Switching components (M=-.321, SD=.603) for Older age group and (M=-.403, SD=.434) for the Monolinguals, with t (28) = -. 424, p= .675, two-tailed. T-test analysis representation is provided at table 6.

Table 6

Mean score differences of the two age groups at EC components.

Variables	Younger (n=16)		Older (n=14)		t (28)	p
	M	SD	M	SD		
WM	1.616	1.950	1.768	.894	.280	.782
IC	-1.198	4.610	-3.277	4.776	-1.209	.237
SC	-.403	.434	-.321	.603	.424	.675

Levene's test is significant at the 0.05 level, (two-tailed). Note. WM=Working Memory components, IC=Inhibition Components, SC=Switching Components.

Discussion

The present study tried to investigate the effects of an unexplored type of Geek bidialectalism, called Pontic-Greek, with the use of several experimental conditions. The experimental design was based on several cognitive task able to measure Executive Control Components, between two different age groups of Greek monolinguals and Pontiac-Greek multilinguals. Two separate analyses conducted, one through the two language Groups and one through the Greek -Pontiac group, based on their performances on EC.

Our first research question was based on whether the impact of dialectism contributes the same as the bilingualism. Research (see Antoniou et al., 2016; Antoniou and Spanoudis, 2020) highlights the acquisition and use of two close varieties of language contributes to an overall EC advantage. Compared to that, our data failed to find clear advantage as no differences found in the performances of the two groups at overall EC, even though the group of bidialectal scored faster compared to monolinguals, our analysis did not reach significance . However, we still support the BECA as our two groups were not matched in age, supporting that bilingualism enhance EC performances even in older ages. Hence, as our two groups differ in terms of language characteristics our data supports our first hypothesis that the knowledge of dialects can also considered to enhance EC performances, similarly as multilingualism do. It seemed that the knowledge of the two dialects provides an advantage on older age groups, as their performances were similar to younger age participants on overall EC performance.

The second research question examined in the present study was whether the BECA is achieved through a coordination of the three main EC components based on Miyake's model (2000). Studies on bi-dialectism did not found any differences on the performances of the three EC components (Antoniou and Spanoudis, 2000), while others on switching components (Sorace, 2016).However, our analysis revealed a significant effect between multilingualism and Working memory where the bi-

dialectal group outscored the monolingual on Working memory components. Consistently, with previous reports it seemed that the knowledge of second languages seemed to enhance working memory capacities (Grundy and Timmer, 2016). This is possible achieved as the bilinguals constantly experiences managing two languages to compete their selection. Taking into consideration that our research is focusing on older age populations it seemed that working memory is an important factor of BECA and is clearly enhanced by the knowledge of two or more languages. As our findings are inconsistent with the basic model of EC proposed by Miyake et al . (2000) , they are highlighting the need of further research, raising the same time questions of whether some EC components minimize their abilities during late adulthood or whether some been advanced through practice.

Hence, even though some studies support that the BECA does not exist (Paap,2019),we consider the age differences of our groups supporting that first the knowledge of two dialects enhances executive control performances based on the significant differences on working memory components between the two groups and that the knowledge of languages provides shields through age-related processing declines as no differences found in their performances. Studies on age related cognitive decline, revealed reduced function on hippocampal brain structures and on Working Memory (Park et al., 2002). Early research on older population showed deficits in their performances on recall and recognition tasks, compared with slower reaction times on switching component task (Salthouse, 1988). Additionally, studies on Simon Task (Van del Lubbe & Verleger, 2002), Flanker task (Bialystok, Craik & Ryan, 2006) and Stroop task (McDown &Shaw, 2000), also found that older populations need more time to resolve and respond on those tasks, supporting that age-related cognitive decline is associated with attention and more specific with the EC. Respectively, our findings supports that the knowledge of two dialects can also positively contribute on age related declines, as many attention components remains intact.

Differences between the two groups were not only on age but also on emigration statues which can be easily considered as confound factors, fact that seriously need some consideration. The group of monolinguals were university students', and we cannot characterize them as immigrants, as Cyprus is not only culturally and linguistically closed to Greece but also ethnically. From the other hand, the group of Pontian-Greek born at Pontic region and almost all of them emigrated to Russia or Georgia before their return to Greece and their final move to Cyprus. So according to their background they all shared similar immigration and Socio-economic status. It is known that emigration variable is possible to confound the analysis as studies support those emigrants have better scores on several cognitive aspects (Paap, 2019), while other found it on cultural. On a study by Carlson and Choi (2009), the bilingual advantage found between groups of different cultural backgrounds between Korean-English bilinguals who lived in United States and American monolingual but not between Korean -English Bilinguals and Korean monolinguals, supporting those cultural differences also plays an important role on Bilingual advantage. According to that, we cannot conclude that our data is

clearly influenced by emigration or cultural statues as our group clearly have cultural similarities as they share the same religion, they both live in very close geographic proximity and have Greek heritage and can be clearly considered as a limitation to our study. Similar studies on bidialectal advantage used three groups of interest with an extra addition of only dialectal group instead of multilinguals bi-dialectals and monolinguals, eliminating the possibility of such a confound factor (Antoniou and Spanoudis, 2020).

The second analysis focused on the differences between younger and older age multilingual and bi-dialectal group responses on overall EC performances. As our researcher met our hypotheses, both groups showed non-significant differences in all EC components, supporting that the BECA advantage is also achieved even on older age groups and not only on younger ages. The above finding is considered as the most important contribution of our study, as it highlights that, not only the knowledge of two different languages prevents cognitive declines but also the knowledge of dialects. As predicted the two groups showed no differences in their performances, beside their age differences. The background analysis also revealed a significant difference in WASI matrix performances between the two groups where younger age group performed higher compared to Older, possible due to age difference. However, this difference seemed that did not influence their cognitive abilities as non-differences observed in their EC performances. Our groups did not differ in terms of language acquisition, education, emigration and socio-economic statues, their differences cannot attributed as confound variables. The language proficiency measured with the use of background information questionnaire based on participants' responses, however it seemed that more specific Vocabulary measures are a valuable addition, as similar studies revealed that possible linguistic differences between multilinguals and monolinguals contributes as important covariate factor for the investigation of the BECA (Antoniou and Spanoudis, 2020).

To continue, the present study came across many limitations as the small number of participants, with 62 participants in total (32 monolinguals and 30 multilinguals bi-dialectals) for the exploration of the first hypothesis and 30 participants (14 Younger and 16 Older) for the second hypothesis or the analysis of only two experimental groups. An extra addition of at least another group of ''pure'' bi-dialectals, probably on older age ,would be necessary for the limitation of any confounds, which clearly weak our analysis. We also forced to exclude some important tasks due to law accuracy levels, this act conducted unable to composite our tasks together and finally to present a stronger experimental design, as our Working Memory and Inhibition components were based on a single task. Another important account would be the inclusion of a verbal task as the bilingual advantage been found to inhibit the auditory processing as well (Bak et al., 2014). Recent, research focused not only on non-verbal but also on auditory stimulus with the use of Test of Everyday Attention (TEA), measuring the cognitive performances of three different Groups of bidialectal. The bilingual groups outscored on inhibition and switching components compared to monolinguals, supporting that the

BECA is also positively contribute on auditory information processing as well (Sorace,2016). As our research, mainly focused on age related cognitive declines we believe that the addition verbal tasks will reinforce our hypothesis that the knowledge of more than one language does provide support to our cognitive abilities.

Conclusion

In overall, the present study supports that the knowledge of a dialect contributes positively on several EC functions, similarly to bilingualism. Most of the studies on BECA mainly focused on young children, however our data revealed that is also possible to remain active on older ages, with positive effects on cognitive health by preventing age related cognitive declines. However, the remaining questions is whether the BECA can be found on a non-emigrated group of bidialectal, such as older aged group of Greek-Pontic dialectals, compared to a multilingual and bidialectal group of Greek-Pontic.

Acknowledges

First, I would like to express how extremely grateful and thankful I am to my supervisor Dr. G., Spanoudis for his valuable advises and support during my research at every stage. I would also like to express my gratitude to the members of the evaluation committee, Dr. T., Papadopoulos, and Dr. F., Constantinidou for their help and recommendations they gave me during the proposal and final stage and finally the Pontic-Greek club ‘’Panagia Soumela’’ and the undergraduate students of Cyprus University who volunteer as participants in the study.

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