Эмпирические исследования
Empirical researches

DOI: 10.51217/npsyresearch_2021_01_04_03

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The Effect of Bilingualism on Executive Functioning Found in Young Adults: an eye-tracking study

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Влияние билингвизма на исполнительные функции у молодых людей: ай-треккер исследование

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The effect of bilingualism on executive functioning (EF) has long been a topic of discussion across the psycholinguistic field. It was previously assumed that acquiring two languages simultaneously may have an effect on the child's cognitive development. This claim was later rejected and opposed by researchers who found that being fluent in two languages provides more cognitive benefits, than being fluent just in one language. Furthermore, neural processing in a bilingual brain influences several cognitive domains that were introduced by Miyake and Friedman's framework, which explains the high inter-connectivity between specific executive functioning domains, such as inhibiting, monitoring, and updating. *Aims and Methods*: The current paper focused on establishing whether being bilingual aids executive functioning in a young adult population. Both monolingual (N = 16) and bilingual (N = 14) participants were tested on a number of cognitive tests. An eye-tracker was used to test inhibitory control, using pro- and anti-saccade conditions. Further, a multitasking and visuospatial working memory capacity task were completed using the press-pad. It was hypothesized that bilinguals will make less errors and initiate a faster response in comparison with monolinguals. However, no significant bilingual cognitive advantage was found in the three EFs components. However, bilinguals did initiate a saccade response faster in the inhibitory control task, while maintaining the same level of accuracy as the monolingual group. Future research should focus on improving the current paper design flaws as well as to include questionnaires for SES and IQ.

Key words: executive functions, bilingualism, visuo-spatial working memory, inhibitory control, multitasking, eye-tracking

For citations: Pshonkovskaya, P., Ballieux, H. (2021). The Effect of Bilingualism on Executive Functioning in Young Adults: an eye-tracking study. *New Psychological Research,* 4, 47–70. DOI: 10.51217/npsyresearch_2021_01_04_03

Background

Historically, bilingual cognitive advantage has been a main topic of debate across the psycholinguistic field. In the early 40s and up to the mid 60s, many studies advocated that nurturing a child in a bilingual environment causes irreversible harm to their cognitive development (Darcy, 1946). However, a study conducted by Peal and Lambert (1962) testing French-English bilinguals has changed previously held negative opinions on bilingualism. Their conclusions showed that bilingual children outperformed monolingual peers on a battery of cognitive ability tests. Bilingualism can be sub-divided into three main groups: simultaneous, sequential, and late. Simultaneous bilingualism indicates language acquisition in parallel before the age of three, sequential bilingualism means consecutive acquisition of the two languages, and late bilingualism is the acquisition and fluency in a second language after the age of 12 (D'Acierno, 1990). According to D'Acierno (1990), bilingual advantage becomes indistinguishable after the puberty and until late adulthood. Although there is still no clear explanation of why the difference can be distinguished in one age population and not in another. A couple of studies propose that the link might be associated with the PFC maturation process (Costa et al., 2008; Anderson et al., 2018).

The interest in the effect of bilingualism on cognitive advantage increased after several studies confirmed the bilingual advantage in non-language-related domains (Ye, Zhou, 2009; Genesee, Nicoladis, 2007). Some studies have specified that bilingual cognitive advantage only arises when a person uses both languages for an equal amount of time (Cummings, 1983; Bialystok et al., 2009; Kroll et al., 2012), resulting in the two languages being actively available at the same time (Bialystok et al., 2004; Kroll, Bialystok, 2013). However, someone who is fluent in two languages has to constantly choose the language appropriate for the situation and supress the inappropriate one by involving executive functions (EFs; Kerns et al., 2004; Abutalebi, Green, 2008; Fedorenko, 2014).

EFs are used as an umbrella term to cover the wide range of cognitive processes originating in the prefrontal cortex (PFC; Pribram, 1976; Diamond, 2013). Miyake and Friedman (2000) introduced a cognitive framework consisting of three highly interconnected cognitive processes: updating, inhibiting, and monitoring. These components were found to be closely tied to bilingual cognitive advantage in non-language-related cognitive domains. Bilingual brain studies suggest that there might be a neuroanatomical explanation for why bilingualism may have a particular effect on the cognitive domains in the PFC. The dorsolateral prefrontal cortex (DLPFC) and anterior cingulate cortex (ACC) areas that are most engaged in executive control (Costa & Sebastian-Galles, 2014). They specialise in the detection and resolution of cognitive conflicts, whereas the left inferior frontal gyrus (LIFG) is in charge of inhibiting irrelevant semantic stimuli. Previous studies conducted using fMRI have found involvement of those mentioned above executive control areas that are being responsible for 8 cross-linguistic conflict in bilingual individuals (Luo et al., 2010; Foursha-Stevenson & Nicoladis 2011; Yang et al., 2014). Moreover, the same brain regions seem to manage non-linguistic cognitive control tasks in monolinguals (Weissberger et al., 2015). These findings may indicate that the bilingual brain develops an overlap of language control and executive functioning in the ACC, DLPFC, and LIFG (Botvinick et al., 2004).

Bilingualism and Inhibitory control

Linguistic inhibition is a term that describes the mechanism behind the suppression of language that is irrelevant to the context. Christoffels et al. (2006) suggested classifying linguistic inhibition into two subgroups: local and global inhibition. Local inhibition stands for inhibiting the small parts of the lexicon, for instance, sentences and phrases, whereas global inhibition implies inhibiting language as a whole. According to Philipp and Koch (2009), global inhibition also accounts for inhibitory function in non-language-related cognitive domains. Several studies that were performed using an eye-tracker showed that global inhibition is also responsible for suppressing non-linguistic tasks (Blumenfeld & Marian., 2014; Mercier et al., 2014; Blumenfeld et al., 2016).

Farrington (2016) researched this hypothesis further testing monolingual and bilingual children. Their findings showed that the bilingual children outperformed the monolinguals on a number of non-language-related inhibitory tasks. In contrast, some studies indicate that the impact of bilingualism on inhibitory control is primarily language dependent (Paap & Greenberg, 2013; Ratiu et al., 2017; Paap et al., 2018). Bialystok et al. (2006) conducted an eye-tracking study in which they compared bilingual and monolingual young adults on saccade initiation in pro- and anti-saccade conditions. Their findings showed no significant differences in number of errors made between the two groups.

Bilingualism and Multitasking

The shifting (multitasking) component in Miyake and Friedman's framework is the ability to shift mental resources between certain tasks, such as attention or working memory. Bilingual people seem more successful in multitasking due to their constant training in switching between languages (Garbin et al., 2010; Gold, 2013; Pelham, Abrams, 2014; Sorman et al., 2017). A couple of fMRI studies further found that when bilinguals are multitasking, they rely less on switching costs, when compared to monolingual peers (Garbin et al., 2010; Gold, 2013). Switching involves constant processing, recognition, and production of both languages simultaneously (Branzi et al., 2016). Bilinguals need to hold two different sets of rules in mind for both languages, and their ability to multitask is expressed through choosing and responding with the language appropriate for the situation (Ameel et al., 2005; Martin et al., 2009).

Bialystok et al. (2009) suggested that switching between lexemes may positively affect other non-language-related cognitive domains. Pelham and Abrams (2014) designed attentional conflict resolution tasks performed by early- and late-bilingual, and monolingual participants. They found that both bilingual groups outperformed the monolingual group on response speed capacity. Further, Sorman et al. (2017) tested older adults (age range 40–65 years) on a series of multitasking tests, and found that bilinguals responded faster with a minimal mental switch cost.

Bilingualism and Visuospatial working memory

The effect of bilingualism on working memory (WM) is not entirely clear. Prior research suggests that being fluent in two languages aids working memory functioning (Kane et al., 2001; Chee, 2009; Blom et al., 2014; Kerrigan et al., 2017). However, Bialystok (2009) claim that bilingualism does not influence WM capacity. According to a review by Calvo et al. (2016), the bilingual cognitive advantage in WM may be considered an overstatement. They state that some effect can indeed be observed, but only in visuospatial working memory, whichis responsible for the recollection of non-semantic linguistic information (Baddeley, Hitch, 1974; Miyake, Friedman, 2000).

Previous studies have investigated the bilingual effect on visuospatial WM in early childhood (Morales et al., 2013; Kerrigan et al., 2017). Morales et al. (2013) conducted the Frogs Matrices Task, an updated Corsi Block Task (Corsi, 1972), on bilingual and monolingual children, and found that bilingual children outperformed monolingual peers. In this task children were divided into two groups, sequential and simultaneous. The participants in the sequential group were required to recall in what order the frogs would appear in the pond. The participants in simultaneous group were asked to recall in which ponds they saw the frogs with no requirement of order. According to the study conducted by Lukasik et al. (2018), the mixed findings were observed in bilingual young adults, when compared to monolinguals. Also, they have suggested to revisit the claim of bilingual cognitive advantage in visuospatial WM domain.

Aim

To our knowledge, not many studies have been conducted on young adults who are bilingual, compared to studies on bilingual children and the elderly population. Partially it may be attributed to the fact that cognitive performance peak is observed at the age of 25 due to the PFC maturation (Fjell et al., 2017; Yu et al., 2018). It could suggest that monolinguals may perform cognitive tasks equally well and potentially making the bilingual cognitive advantage indistinguishable at this particular age group (Costa et al., 2008; Anderson et al., 2018). Therefore, to the current study tried to address this gap by investigating whether bilingual young adults show a cognitive advantage in comparison to monolingual peers on 3 executive function tests. The first hypothesis was that bilinguals will make less errors on a inhibitory control, multitasking, and visuospatial WM task. The second hypothesis was that bilinguals will perform these tasks faster than the monolinguals.

Methods

Design

The experimental design of the current study used a quantitative approach.

Participants

For this study, we analysed the data collected from 30 university students. The age range of the participants varied from 18 to 35 years old (bilinguals mean age = 22, SD = 1.84; monolinguals mean age = 24, SD = 4.03). The main decisive factor for participation was the participants' fluency in one or two languages and how often bilingual participants use their second language of dominance. The frequency of second language use factor was assessed through the self-completed questionnaire, where participants were asked which language they prefer when reading, watching TV and speaking with people, who understand both languages, etc. In the current study we used the adapted version of the LEAP Questionnaire, set up in Qualtrics (Provo, UT; Marian et al., 2007). All recruited monolinguals (n = 16) reported English as their native language. All the bilingual participants (n = 14) reported proficiency in English and one other non-English language. The non-English languages spoken by bilingual participants included Russian, Bengali, Urdu, Punjabi, Estonian, Lithuanian, Chinese, Yoruba, Polish, German, Spanish, and Italian. We assigned bilinguals to three groups: simultaneous, sequential, and late bilinguals (see Table 1). Out of the 14 bilinguals, one was appointed to the simultaneous group (exposed to both languages since birth), 11 participants were appointed to the sequential group (began acquiring at a mean age of 4 years), and two bilinguals were labelled as late bilinguals (began acquiring at a mean age of 14.5 years).

Table 1. Level of exposure, proficiency, and reading preference in the Bilingual Group

	Native Language %	**Second Language %**
Current Level of Exposure	**37.5**	**62.5**
Level of Proficiency	**58**	**42**
Language Preference in Reading	**39**	**61**
Choice of Language to Communicate with Interlocutor Equally Fluent in Both	**42.5**	**57.5**

Materials and Procedure

The first experiment was performed using a TX300 Tobii Eye-Tracker (Software version 3.2, 2012) and aimed to evaluate inhibitory control ability. The experimental setup is illustrated in Figure 1. The participants were instructed to follow two sets of rules and avert their eye-gaze in accordance with the presented condition. The set conditions were divided onto pro-(green eyes) and anti-(red eyes) saccade. In the pro-saccade condition participants were asked to avert the gaze towards the asterisk, whereas in the anti-saccade condition the participants were required to look at the empty box. The eye stimuli would appear on the screen for 2000ms, then followed by a blank boxes screen for 500ms. The asterisk slide would appear for 1500ms and would require participants to act in accordance with the instructions explained above.

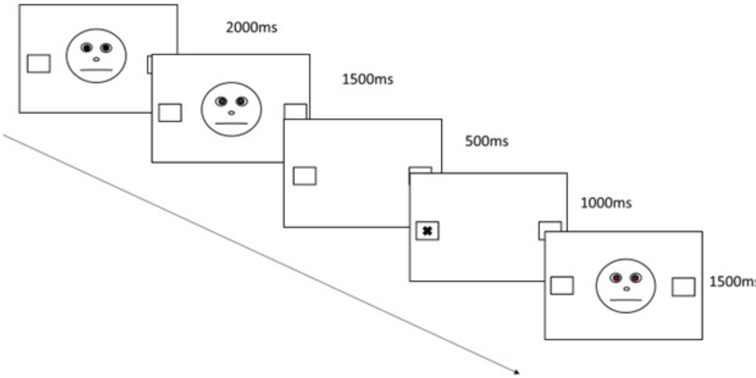

Figure 1. Set-up of the pro-saccade (green eyes) and anti-saccade (red eyes) conditions in the eye-tracker Response Inhibition task.

The CANTAB software package was installed on an iPad iOS 13.1 to conduct the following two experiments. The first one was the Multitasking task (MMT) that measured task switching ability. Both groups were asked to complete congruent (focusing on the direction of the pointing arrow), incongruent (focusing on the side the arrow is located, while disregarding the direction), and mixed block (congruent/incongruent combined) conditions (see Figures 2). Participants were asked to press a left/right button on the iPad screen in accordance with arrow direction or side, depending on the condition.

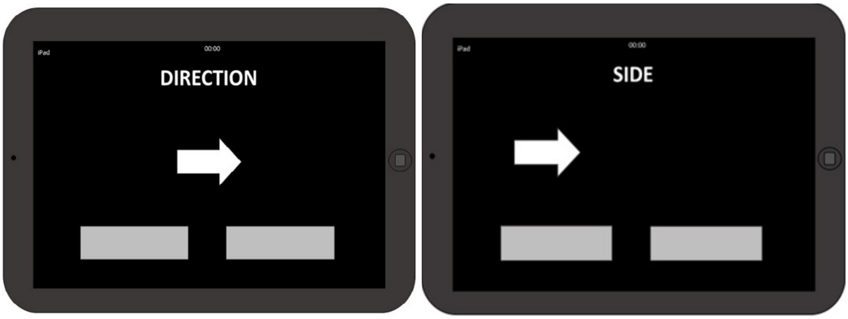

Figure 2. The experimental CANTAB software set-up for the MMT task, representing Congruent and Incongruent, as well as a Mixed block condition.

The second CANTAB task was the Spatial Span task that measured visuospatial working memory capacity. Participants were given a practice trial first where they had to memorise the location of three squares. They were asked to recall the squares after a sound indication by pressing the squares in the order they were shown (see Figure 3). Overall, the maximum number of squares was 9. If the participant would make three errors in a row the trial would stop.

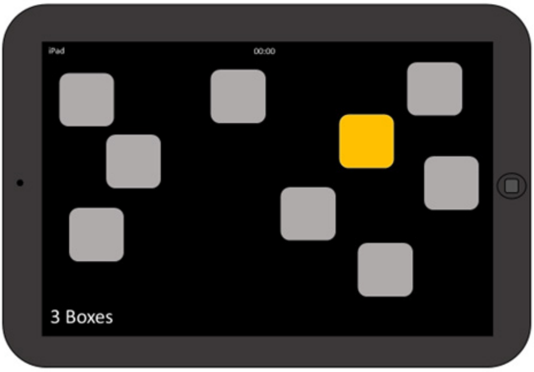

Figure 3. The experimental CANTAB software set-up for the SSP task.

Results

Descriptive and inferential statistics were performed using IBS SPSS software (Version 24), and statistical significance was set at alpha levels .05.

Inhibition Task

A Two-Way Mixed ANOVA was carried out to assess the difference between bilingual and monolingual participants on error scores and reaction times in the pro- and anti-saccade conditions. The results show no significant main effect of language on error scores (F (1,23) = .95, p = .610, $\eta2$ = .01), suggesting that bilingual and monolingual groups performed similarly overall. Also, there was no significant interaction between conditions and language (F (1,23) = .60, p = .446, $\eta2$ = .03).

A significant effect was observed for number of errors between the pro-saccade and anti-saccade conditions (F (1,23) = 10.03, p = .004, $\eta2$ = .30, V = .304). Further, a significant main effect of language on reaction time was detected (F (1,23) = 10.64, p = .003, $\eta2$ = .32). Table 2 and Figure 4 below illustrate that both groups made fewer errors in the pro-saccade condition, but that bilinguals did outperform monolinguals on reaction time in both conditions.

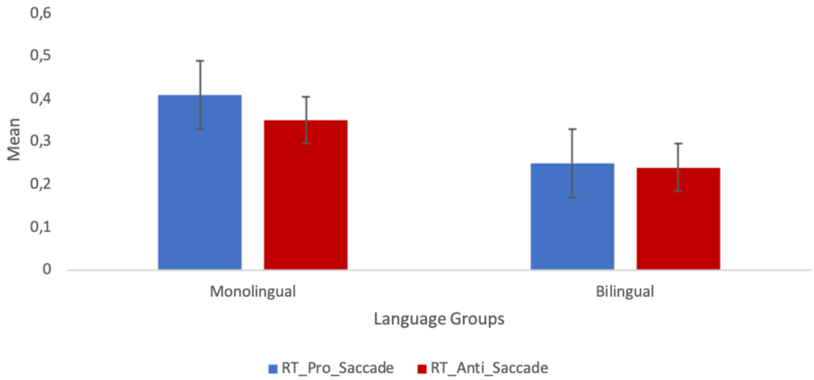

Figure 4. The Mean Reaction Times (in sec.) for Pro- and Anti-Saccade conditions between the Language Groups with the Error Bars set at 95%.

Table 2. Means and Standard Deviations of Number of Errors and Reaction Times (in sec.) in Pro-saccade and Anti-saccade Conditions of both Bilingual and Monolingual Groups

	Bilingual			**Monolingual**	
Condition	***M***	***SD***		***M***	***SD***
			Number of Errors		
Pro-saccade	**0.33**	**0.65**		**0.24**	**0.43**
Anti-Saccade	**1.5**	**1.73**		**2.16**	**3.02**
			Reaction Time		
Pro-saccade	**0.25**	**0.04**		**0.41**	**0.03**
Anti-saccade	**0.24**	**0.06**		**0.35**	**0.05**

Multitasking Task

A Two-Way Mixed ANOVA was performed to compare the error scores and response latencies made by the bilingual and monolingual groups in three conditions: Congruent (Direction), Incongruent (Side), and Mixed Block (Side/Direction). A significant main effect of condition was found (F (2, 56) = 45.46, p = .000, $\eta 2$ = .62), illustrating that both bilingual and monolingual participants performed better on the Incongruent Task condition in comparison to the Congruent and Mixed Block conditions (see Figure 6). The main effect of language groups on error scores showed no statistical significance (F (1,28) = 3.60, p = .068, $\eta 2$ = .11), (for means see Table 3.).

A MANOVA was carried out to test the assumption of language effect on all three conditions. This analysis found no bilingual advantage over the monolinguals in Mixed Block condition (Roy's Largest Root = .141, F (1,28) = 3.09, p= .090). A Two-Way Mixed ANOVA showed no significant between subject main effect of language on response latencies (F (1,28) = 2.01, p = .168, $\eta 2$ = .07), indicating that bilingual and monolingual participants on average completed the tasks with a similar RT (see Figure 5).

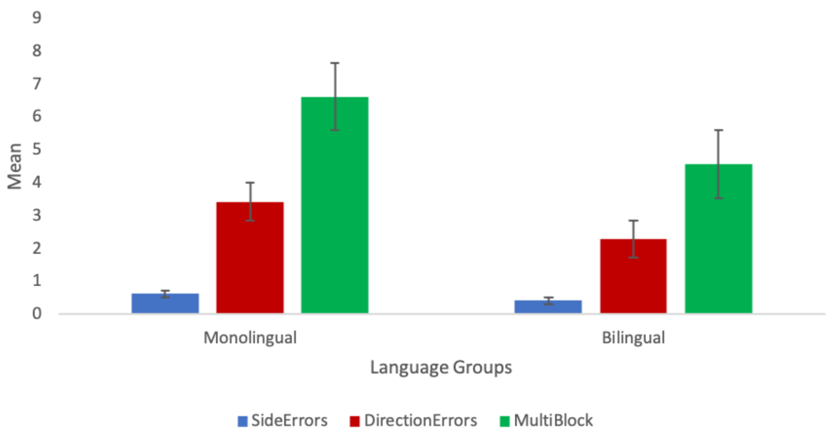

Figure 5. The Mean Error Scores per Condition between Language Groups with Error Bars set at 95%.

Table 3. Means and Standard Deviations of Number of Errors and Reaction Times (in sec.) in Congruent, Incongruent and Mixed Block Conditions in both Bilinguals and Monolinguals

	Bilingual			Monolingual	
Condition	***M***	***SD***		***M***	***SD***
			Number of Errors		
Congruent	**2.29**	**1.72**		**3.43**	**2.76**
Incongruent	**0.42**	**0.65**		**0.63**	**1.02**
Mixed Blocks	**4.57**	**2.47**		**6.63**	**3.70**
			Reaction Time		
Congruent	**0.52**	**0.24**		**0.49**	**0.22**
Incongruent	**0.38**	**0.19**		**0.35**	**0.17**
Mixed Blocks	**0.65**	**0.41**		**0.56**	**0.38**

Spatial Span Task

A One-Way ANOVA was carried out to compare the longest recall and the RT between bilingual and monolingual participants in the Spatial Span Task. There was no statistical significance found for either recall rate ($F(1,28) = 2.76$, $p = .108$, $p > 0.05$) or overall response speed ($F(1,28) = .18$, $p = .679$, $p > 0.05$), indicating that monolinguals performed equally well, when compared to bilinguals on this task (see Table 4).

Table 4. Means and Standard Deviations of Longest Sequence Recalled and Speed of Response (in sec.) in SSP Task in both Bilingual and Monolingual Groups

Bilingual			**Monolingual**	
M	***SD***		***M***	***SD***
		Longest Recall		
6.92	**1.12**		**6.06**	**1.57**
		Reaction Time		
11.23	**5.80**		**12.31**	**7.01**

Discussion

Bilingualism and Inhibitory control

The current paper compared the performance of bilingual and monolingual young adults on their response inhibition ability. The results indicate that the two groups did not differ on the number of errors made in the pro-saccade (to-target) and anti-saccade (away-target) conditions. This is supported by Bialystok et al. (2006) who reported no difference between bilingual and monolingual young adults on a similar task. They suggested that this might be due to the fact that PFC maturation is completed around the age of 25, and that therefore there is no big difference in cognitive performance in general between monolinguals and bilinguals. The so-called 'overriding' attentional process required for controlled inhibition appears to be indistinguishable between the two language groups. However, our findings don't seem to fully fit with this hypothesis, nor with other relevant research (Blumenfeld & Mariam, 2014; Blumenfeld et al., 2016; Mercier et al., 2014).

We found that the bilingual group did, in fact, outperform their monolingual peers on RTs of response inhibition in pro- and anti-saccade initiation. We argue that these findings can be attributed to the cognitive monitoring process, which is more common among people who are fluent in two languages (Bialystok, 2009). As previously mentioned, bilinguals are constantly required to monitor and maintain the relevance and the context of the correct language when performing language-related tasks. Blumenfeld et al. (2016) have reported similar findings in an elderly population but found no difference in a young adult one. They suggested that older bilinguals have had much practice of inhibitory control. Previous studies have shown that the faster RT may negatively affect the accuracy during the task (Wenzlaff et al., 2011; Bialystok et al., 2014). It can be concluded that not only our bilingual group did outperform monolingual group on the reaction speed, but their accuracy performance did not differ. Thus, we could speculate that bilingualism may act as a sort of cognitive "buffer" on the tasks that require inhibitory control. Therefore, the current study findings add to the discussion of whether inhibitory control is indeed practiced or is present throughout the lifespan.

Bilingualism and Multitasking

In the present study we compared multitasking performance of bilingual and monolingual young adults. Both groups were asked to complete congruent, incongruent , and mixed block (congruent/incongruent combined) conditions. Congruent/incongruent conditions were used to assess the global switch costs and the mixed block was used assess the local switch costs, the multitasking. We found no apparent difference of cognitive performances between the bilingual and monolingual groups, indicating a similar number of errors made by both groups. This result contradicts the general consensus in the literature, which claims that bilinguals generally perform better on task-switching, as they are constantly required to switch between the languages (Garbin et al., 2010; Gold, 2013; Pelham, Abrams, 2014; Sorman et al., 2017).

Another reason for no observed effect can be attributed to the sample specifics, as our participants stated to use their native language only at 30% of the time in general. Previous literature has shown that to observe any cognitive effect, bilinguals should maintain an equal level of each language exposure (Cummings, 1983; Bialystok et al., 2009; Kroll et al., 2012). Therefore, there could be a distinguishable bilingual advantage, but future studies should recruit a broader sample size.

Bilingualism and Visuospatial working memory

Previous research has proposed that bilingualism may have an impact on visuospatial working memory (Kane et al., 2001; Chee et al., 2009; Blom et al., 2014; Kerrigan et al., 2017). This is mainly because this WM aspect is responsible for non-semantic language processing (Bialystok et al., 2009; Morales et al., 2013; McVeigh et al., 2019). However, the current study's findings show no significant difference between the bilingual and monolingual groups, which contradicts Lukasik et al. (2018) who reported a significant difference in visuospatial WM for bilingual participants when compared to their monolingual peers. Although, they also claimed that the observed effect size was small, and the Bayes factor established the lack of difference between the groups in other WM tasks. Therefore, Lukasik et al. (2018) determined that the effect found on their visuospatial WM task should not be attributed to bilingualism.

We need to note that the current study used a less cognitively demanding task to measure visuospatial WM capacity than Friesen et al. (2015). According to Friesen et al. (2015), bilinguals did not differ from their monolingual peers on a simple visuospatial WM task, but significantly outperformed them on a more task-demanding condition. Therefore, task difficulty may correlate with higher cognitive performance in bilingual young adults. Future research should focus on exploring how level of task difficulty, particularly in the visuospatial WM domain, correlates with possible cognitive advantage of those fluent in two languages.

Limitations and Directions for future research

The current study tried to address the existing research gap on the effect of bilingualism on executive functioning in young adults. For future research, it would be suggested to implement the changes to the current study design as well as to take into account the number of methodological issues. The limitations of the present study naturally include constrained sample size and a small variety of bilingual groups. It would be beneficial to conduct an experiment with more sequential, simultaneous, and late bilinguals.

In addition, previous studies have pointed out that the bilingual cognitive advantage arises from early childhood (Morales et al., 2013; Kerrigan et al., 2017). Therefore, it would be interesting to compare the potential bilingual effect not only between-groups (bilingual/monolingual) but also on withing-group (sequential/simultaneous/late bilinguals) differences. Also, it is important to note another methodological weakness. No measure of IQ or Socioeconomic status (SES) was taken, when. Cox et al. (2016) reported that both factors can significantly influence the expression of bilingual cognitive advantage in EF components. The main reason not to include an IQ measure was that participants were all BSc students, so no large individual differences were expected.

Conclusion

The current study assessed the effect of bilingualism in young adults on three executive functioning components. The stated hypothesis was that there would be a difference in cognitive performance between bilingual and monolingual groups, where bilinguals would show a cognitive advantage on a multitasking and visuospatial working memory task. We used a Tobii eye-tracker to evaluate response inhibition by assessing the speed of response in pro- and anti-saccade conditions. We also calculated the number of errors made in each condition.

Findings showed no apparent bilingual advantage in the previously mentioned tasks in terms of errors made. However, bilinguals did outperform monolingual peers on the speed of initiating the saccades in both pro- and anti-saccade conditions. This might, therefore, indicate some bilingual advantage, or cognitive 'buffer'. However, more research is needed to confirm this statement. Multitasking and visuospatial WM abilities were assessed using CANTAB battery tests. We have found no evidence for the bilingual cognitive advantage in RTs and errors made in both tasks. We hypothesised that the lack of difference between the two language groups in terms of errors made might also be explained by participants' age range in both groups. All participants were young adults, the age range in which the PFC reaches cortical maturation, resulting in peak cognitive performance and making the bilingual cognitive advantage less apparent.

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Влияние билингвизма на исполнительные функции у молодых людей: ай-трекер исследование

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The Effect of Bilingualism on Executive Functioning Found in Young Adults: an eye-tracking study

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Свободное владение двумя языками может дать определенные когнитивные преимущества по сравнению со свободным владением только одним языком. Предыдущие исследования детей и взрослых дают представление о когнитивных преимуществах двуязычия в такой области, как академическая деятельность, а также о возможной нейрозащите от развития нейродегенеративных симптомов на срок до пяти лет. Кроме того, несколько исследований подтвердили когнитивное преимущество билингвизма у молодых людей, однако это утверждение до сих пор вызывает споры в психолингвистическом сообществе. Мияке и Фридман предложили модель, которая объясняет сильную взаимосвязь между конкретными исполнительными функциями такими, как обновление, торможение и переключение. В соответствии с их моделью исполнительного функционирования в большом числе исследований сообщается о значительном преимуществе двуязычных носителей. Данное исследование направлено на изучение влияния билингвизма на конкретные исполнительные функции. Предстояло выяснить, насколько лучше двуязычные молодые люди (n = 14) справятся с серией когнитивных задач по сравнению со сверстниками, владеющими одним языком (n = 16). Обе языковые группы оценивались по таким заданиям, как задания на торможение реакции, многозадачность и объем зрительно-пространственной рабочей памяти. В задании на торможение реакции мы измеряли время и правильность инициируемых саккад через ай-трекер. Задания на зрительно-пространственную память и многозадачность выполнялись на пресс-паде. Было высказано предположение, что двуязычные респонденты покажут более высокий результат, чем их одноязычные сверстники, делая меньше ошибок и давая более быстрые когнитивные ответы на перечисленные выше задачи. Результаты данного исследования не выявили явных когнитивных преимуществ двуязычия в реакции торможения, многозадачности и зрительно-пространственной рабочей памяти, что указывает на относительно одинаковый уровень двуязычных и одноязычных молодых людей по этим позициям. Однако по времени реакции (RT) в задаче на саккады двуязычные, действительно, превзошли одноязычных сверстников. Более того, полученные результаты обнаружили потенциальную тенденцию преимущества

двуязычной группы в задании на многозадачность, однако они не достигли статистической значимости. Поэтому в будущем представляется важным сфокусировать внимание на недоработках существующего дизайна эксперимента, т.е. либо произвести модификацию имеющегося дизайна, либо предпринять попытки конструирования нового. В целом, исследование вносит значительный вклад как в анализ проблем экспериментального изучения влияния билингвизма на исполнительные функции юношей и девушек, так и в проектирование новых подходов к данным исследованиям.

Ключевые слова: исполнительные функции, билингвизм, зрительно-пространственная рабочая память, контроль импульсивности, когнитивная гибкость, внимание, управляющие функции

Для цитирования: Пшонковская, П.*, Балье, Х.* Влияние билингвизма на исполнительные функции у молодых людей: ай-трекер исследование // Новые психологические исследования. 2021. № 4. С. 47–70. DOI: 10.51217/npsyresearch_2021_01_04_03

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