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Exploring the Effect of Late, Unbalanced Bilingualism on Cognitive Control

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Abstract

One of the most fascinating and enduring mysteries of human cognition concerns the process of cognitive control, a function that depends on the engagement of the prefrontal cortex (Miller, 2000) in order to coordinate thoughts and actions (Koechlin, Ody, & Kouneiher, 2003). Considering language switching as practices to improve the general control mechanisms, the effect of bilingual experience on cognitive control has been a matter of scientific debate in the past two decades. The existence of bilingual advantage, however, has remained highly controversial in the bilingualism literature because of a mix of negative, positive and null effects. The current study investigated the influence of late unbalanced bilingualism on cognitive control among 97 participants aged 18 to 40 years. A group of 63 Iranian monolinguals and 34 Persian-English bilinguals took part in this study and were exposed to a computerized version of Stroop Color and Word Task so as to measure conflict monitoring and inhibition. An independent samples t-test analysis of the Stroop results showed no significant differences in the mean color-word interference effects (RT and score) across both groups. Therefore, late unbalanced bilinguals are not cognitively different from their monolingual counterparts. The study findings indicate that the role of other key variables such as intellectual, physical and social activities should further be considered in dealing with the notion of bilingualism and cognitive control.

Keywords: Bilingual advantage, Late Bilingualism, Unbalanced Bilingualism, Cognitive Control, Stroop Task.

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1. Preliminaries

As the world becomes more interconnected, an increasing number of individuals become bilingual in all classes of society and in all age groups. Consequently, the theory on cognitive advantages of bilingualism is a topic that merits a great deal of attention. During the past 10 years, as Bellegarda and Macizo (2021) report based on the Scopus database, the number of studies on bilingualism and cognitive control has increased from only 2 articles published in the year 2009 to 46 published in the year 2019.

Cognitive control denotes a set of cognitive functions that enable one to control and manage behavior adaptively to achieve current and future goals (Huizinga, Dolan, & Van der Molen, 2006) and prevent responding to irrelevant stimuli (Hübner & Töbel, 2019).

Bilingualism entails having two equivalent words tagged to the same concept (Garbin et al., 2010). Previous studies suggest that both first and second languages are active when only either of them is in use (Kroll, Dussias, Bice, & Perrotti, 2015). Due to this parallel activation, speaking the appropriate language in a different context requires the use of the control network to minimize interferences from the language that is not in intended use (Bialystok, Craik, Green, & Gollan, 2009).

Switching between representational function and preventive interferences in mind is a process automatically controlled by the general executive control system; therefore, bilingualism must be strongly tied to a cognitive system in a way that is less essential for a monolingual speaker(Bialystok et al., 2009).

2. Background and theories

The existence of the bilingual advantage in cognitive control motivated Van den Noort et al. (2019) to investigate the bilingual advantage and its modulating factors. The results of the 46 original studies from 2004 to 2018 concerning bilingualism in different cognitive control tasks indicate that the majority, 54.3%, confirm the beneficial effects of bilingualism on cognitive control; however, 28.3% of the studies arrive at mixed results, and 17.4% provide evidence against its existence.

An early study conducted by Jespersen (1922) demonstrated that a bilingual child hardly learns either language as well as such a monolingual child would have learned a single language. In addition, he maintains that the intellectual effort needed to become skillful at two languages reduces the child's energy to learn other things.

In a psychological article on bilingualism, Bialystok and Craik (2010) investigate the way bilingualism affects cognitive and linguistic performance over the life span regarding both benefits and costs. The only recorded negative view on bilingualism mentioned by Bialystok and Craik is on verbal knowledge and skill-specifically, smaller vocabularies and less rapid access to lexical items. Regarding the advantages, Bialystok (2001) makes the point that not only do bilinguals not suffer from any negative effects of bilingualism on cognition and metalinguistic development, but they also demonstrate enhanced

executive control in nonverbal tasks (Bialystok & Craik, 2010) .

Woumans (2015) also has supported the bilingual advantage phenomena by the hypothesis that a bilingual's two language systems are activated at the same time. The bilingual speaker's effort to speak one language while suppressing interference from the other is reported to be strenuous and leads to the cognitive benefits in non-verbal areas. Given the above, Woumans (2015) argues that cognitive functioning is affected by bilingualism both in children and in different adult populations.

The earlier literature followed an evaluation from negative to positive view on bilingualism. The current trend, however, is toward null results. A very recent extensive meta-analysis conducted by Lehtonen et al. (2018) compared bilinguals' and monolinguals' performances in six different executive domains using 891 effect sizes from 152 studies on adults. These authors could not find systematic evidence for larger bilingual-monolingual differences in older adults either.

Although there are inconsistencies and controversies regarding the brain benefits of bilingualism, bilingual advantages can be real if and when a more holistic approach is designed (Hilchey & Klein, 2011; Kroll & Bialystok, 2013). Absence of bilingual advantages in some of previous studies is due to a series of factors. Some researchers do not consider language history such as age of acquisition, language proficiency, and language use context which play an important role, as well as other participant-relevant variables including age, socio-economic situation, and intelligence (Valian, 2015).

Age of second language acquisition is one well-studied construct that is known to impact language and neurocognitive processing (Berken, Chai, Chen, Gracco, & Klein, 2016; Gullifer et al., 2018). In a study conducted by Luk, De Sa, and Bialystok (2011), young monolingual and bilingual adults who were about 20 years old were examined for English proficiency, language use history, and performance on a flanker task. Depending on whether they became actively bilingual before or after the age of ten years, the bilinguals were divided into two groups of early and late ones. They found that early bilinguals produced the smallest response time cost for incongruent trials as flanker effect, while late bilinguals and monolinguals showed no difference from each other.

Moreover, there seems to be a positive relationship between language proficiency and generic executive control in inhibition (Iluz-Cohen & Armon-Lotem, 2013). Zied et al. (2004) compared the functioning of inhibitory mechanisms in younger and older bilinguals using a bilingual version of the Stroop test. They considered different patterns of age related decline in inhibitory mechanisms in bilinguals depending on their level of proficiency. Balanced bilinguals at both age groups responded more rapidly than unbalanced bilinguals in a Stroop task.

In 2011, Salvatierra and Rosselli conducted a study to investigate the effects of balanced and non-balanced bilingualism on inhibitory control in which younger and older Spanish—English bilinguals and English monolinguals participated. Their findings reported that even late bilinguals may show strong inhibitory advantages with a balanced daily exposure to both of their languages. Level of linguistic activation, therefore, has shown a greater impact on positive effects of bilingualism than language proficiency (Lee Salvatierra & Rosselli, 2011).

To sum up, bilingualism is a multidimensional and continuous phenomenon (Gullifer et al., 2021) and

differences in bilinguals may affect the abilities of cognitive control. Two general types of bilingual speakers, according to Houston (2019), are termed as primary and secondary bilinguals. A primary bilingual learns two languages in a natural speech situation whether the two languages were acquired at the same time or after each other; by contrast, a secondary bilingual studies a second language formally.

Although extensive research has been carried out on bilingualism, there has been little discussion which adequately covers secondary bilingual advantages in cognitive control who are mostly late unbalanced bilinguals. The present study with other relevant demographic variables being well-matched such as age, gender, education, age of language acquisition, and context of language use tries to illuminate the impact of late, unbalanced bilingualism on cognitive functioning among young adult Persian-English bilinguals.

3. Methodology

The present study enjoyed a cross-sectional study including 97 volunteers aged 18 to 40 years who were classified in two discrete groups. Participants consisted of 63 monolinguals and 34 bilinguals who were selected through convenience sampling. The bilinguals were proficient at speaking skills and used it often because of their field of study or occupational status. They did not acquire the second language in a natural speech situation, but rather learned English formally in language institute or university in early adolescence or adulthood. Monolingual young adults comprising less educated or educated ones, however, could not speak in any other languages; they were Persian speakers only. Concerning the gender, there were 43% males and 57% females in the monolingual group and 44% males and 56% females in the bilingual group which corresponds to 42 males and 55 females in total. The average age of all participants was 25.9.

Demographic questionnaire and Stroop Color and Word Task were administered to all participants in the current research. The questionnaire of demographic information was prepared containing questions about age, gender, country of origin, occupational status, formal education level and physical and cognitive activity. Participants were also asked about the age of second language acquisition. Furthermore, they provided self-rated level of proficiency in the second language.

The Stroop Color and Word Task, commonly used as an interference-control task, has been used on participants in which irrelevant activation produces a response conflict that has to be resolved by mental control mechanisms (Stroop, 1935). Different types of this non-verbal conflict task have been developed. In the present study, however, computerized version of Complex Stroop Task (Khodadadi, Saremi, Khayati & Amani, 2014) was used including 480 color-words divided into 240 congruent and 240 incongruent trials. The time for each stimulus to be displayed on the screen was 1 second and to avoid getting used to the distance between the two stimuli, these were 550, 650, 750, 850, and 950 thousandths of a second, which were applied evenly and randomly.

In this study, the mean color-word interference score and the mean color-word interference reaction time (RT) have been reported. These two indicate the mean color-word interference effect due to the incongruence between the color and the printed word (dos Santos Assef, Capovilla, & Capovilla, 2007).

The comparison of quantitative variables between the two monolingual (n=63) and bilingual (n=34)

groups was performed using independent-samples t-test. There was no statistically significant difference in the interference score for monolinguals (M=2.60, SD=5.18) and bilinguals (M=2.94, SD=7.93) (t (95) =-.25, p =.80, two-tailed), nor in the interference reaction time for monolinguals (M=33.02, SD=23.41) and bilinguals (M=28.44, SD=20.12) (t (95) =.96, p =.34, two-tailed).

4. Discussion and Conclusion

The results of the present study seem to be at odds with some previous research findings on bilingual cognitive effect (Bialystok, 2017; Costa, Hernández, & Sebastián-Gallés, 2008; Kroll & Bialystok, 2013). There were not any significant bilingual advantages in the Stroop task. This was in line with certain other studies that did not find systematic evidence for cognitive advantages of bilingualism (Antoniou, 2019; Jones, Davies-Thompson, & Tree, 2021; Laketa, Studenica, Chrysochoou, Blakey, & Vivas, 2021; Paap, Johnson, & Sawi, 2015).

In our study, all participants had learned the second language after the age of 10, and thus are considered as late bilinguals. This can be one reason for the lack of the significant observed effects. It has been suggested that the earlier age of acquisition and higher language proficiency, the greater the bilingual advantages in cognitive control (Luk et al., 2011). Hence, the results might turn out to be significant if early bilinguals are tested on the cognitive tasks. Moreover, the level of linguistic activation with a balanced and daily involvement of this control system in handling the two languages mostly caused by natural contexts can be much more effective to strengthen the system (Lee Salvatierra & Rosselli, 2011). The participants of the present study did not have a daily or balanced involvement in the two languages and this may have contributed to the lack of a significant difference in the results.

In addition to subject matter or the complexity of bilingualism, we agree with Xie that most previous works have been carried out on cognitive differences between bilinguals and monolinguals. To identify which aspect of bilingualism contributes to bilingual advantage, more attention should be paid to compare discrepancies between different groups of bilinguals (Xie, 2018).

Several studies have shown that cognition is malleable and sensitive to wide range of cognitive learning experience in everyday activities (Bediou et al., 2018; Goldin et al., 2014; Mackey, Hill, Stone, & Bunge, 2011). To be able to conclude whether bilingualism can promote cognitive control, therefore, the significant effect of variables such as intellectual, physical and social activities in participants' everyday life also is worth considering. The higher level of bilinguals' cognition in prior literature is, perhaps, because of individuals' background and milestones of various cognitive activities rather than purely a consequence of being bilingual.

References

Antoniou, M. (2019). The advantages of bilingualism debate. *Annual Review of Linguistics, 5*, 395-415.

Bediou, B., Adams, D. M., Mayer, R. E., Tipton, E., Green, C. S., & Bavelier, D. (2018). Meta-analysis of action video game impact on perceptual, attentional, and cognitive skills. *Psychological bulletin, 144*(1), 77.

Bellegarda, M. A., & Macizo, P. (2021). Cognitive control and bilingualism: The bilingual advantage through the lens of dimensional overlap. *Frontiers in psychology, 12*, 173.

Berken, J. A., Chai, X., Chen, J.-K., Gracco, V. L., & Klein, D. (2016). Effects of early and late bilingualism on resting-state functional connectivity. *Journal of Neuroscience, 36*(4), 1165-1172.

Bialystok, E. (2001). *Bilingualism in development: Language, literacy, and cognition*: Cambridge University Press.

Bialystok, E. (2017). The bilingual adaptation: How minds accommodate experience. *Psychological bulletin, 143*(3), 233.

Bialystok, E., & Craik, F. I. (2010). Cognitive and linguistic processing in the bilingual mind. *Current directions in psychological science, 19*(1), 19-23.

Bialystok, E., Craik, F. I., Green, D. W., & Gollan, T. H. (2009). Bilingual minds. *Psychological science in the public interest, 10*(3), 89-129.

Costa, A., Hernández, M., & Sebastián-Gallés, N. (2008). Bilingualism aids conflict resolution: Evidence from the ANT task. *Cognition, 106*(1), 59-86.

dos Santos Assef, E. C., Capovilla, A. G. S., & Capovilla, F. C. (2007). Computerized Stroop test to assess selective attention in children with attention deficit hyperactivity disorder. *The Spanish journal of psychology, 10*(1), 33-40.

Garbin, G., Sanjuan, A., Forn, C., Bustamante, J. C., Rodríguez-Pujadas, A., Belloch, V., . . . Ávila, C. (2010). Bridging language and attention: Brain basis of the impact of bilingualism on cognitive control. *Neuroimage, 53*(4), 1272-1278.

Goldin, A. P., Hermida, M. J., Shalom, D. E., Costa, M. E., Lopez-Rosenfeld, M., Segretin, M. S., . . . Sigman, M. (2014). Far transfer to language and math of a short software-based gaming intervention. *Proceedings of the National Academy of Sciences, 111*(17), 6443-6448.

Gullifer, J. W., Chai, X. J., Whitford, V., Pivneva, I., Baum, S., Klein, D., & Titone, D. (2018). Bilingual experience and resting-state brain connectivity: Impacts of L2 age of acquisition and social diversity of language use on control networks. *Neuropsychologia, 117*, 123-134.

Gullifer, J. W., Kousaie, S., Gilbert, A. C., Grant, A., Giroud, N., Coulter, K., . . . Titone, D. (2021). Bilingual language experience as a multidimensional spectrum: Associations with objective and subjective language proficiency. *Applied Psycholinguistics, 42*(2), 245-278.

Hilchey, M. D., & Klein, R. M. (2011). Are there bilingual advantages on nonlinguistic interference tasks? Implications for the plasticity of executive control processes. *Psychonomic bulletin & review, 18*(4), 625-658.

Houston, S. H. (2019). 14. Bilingualism: Naturally Acquired Bilingualism *A survey of Psycholinguistics* (pp. 203-214): De Gruyter Mouton.

Hübner, R., & Töbel, L. (2019). Conflict resolution in the Eriksen flanker task: Similarities and differences to the Simon task. *PloS one, 14*(3), e0214203.

Huizinga, M., Dolan, C. V., & Van der Molen, M. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia, 44*(11), 2017-2036.

Iluz-Cohen, P., & Armon-Lotem, S. (2013). Language proficiency and executive control in bilingual children. *Bilingualism: Language and cognition, 16*(4), 884-899.

Jespersen, O. (1922). Language: Its Nature. *Development and Origin, 396*.

Jones, S. K., Davies-Thompson, J., & Tree, J. (2021). Can Machines Find the Bilingual Advantage? Machine Learning Algorithms Find No Evidence to Differentiate Between Lifelong Bilingual and Monolingual Cognitive Profiles. *Frontiers in human neuroscience, 15*, 59.

Khodadadi, M., Saremi, M., Khayati, F., & Amani, H. (2014). Complex Stroop Soft Ware, Institute for behavioral & cognitive sciences. Tehran, Islamic Republic of Iran.

Koechlin, E., Ody, C., & Kouneiher, F. (2003). The architecture of cognitive control in the human prefrontal cortex. *Science, 302*(5648), 1181-1185.

Kroll, J. F., & Bialystok, E. (2013). Understanding the consequences of bilingualism for language processing and cognition. *Journal of cognitive psychology, 25*(5), 497-514.

Kroll, J. F., Dussias, P. E., Bice, K., & Perrotti, L. (2015). Bilingualism, mind, and brain. *Annu. Rev. Linguist., 1*(1), 377-394.

Laketa, A., Studenica, A., Chrysochoou, E., Blakey, E., & Vivas, A. B. (2021). Biculturalism, linguistic distance, and bilingual profile effects on the bilingual influence on cognition: A comprehensive multipopulation approach. *Journal of Experimental Psychology: General*.

Lee Salvatierra, J., & Rosselli, M. (2011). The effect of bilingualism and age on inhibitory control. *International Journal of Bilingualism, 15*(1), 26-37.

Lehtonen, M., Soveri, A., Laine, A., Järvenpää, J., De Bruin, A., & Antfolk, J. (2018). Is bilingualism associated with enhanced executive functioning in adults? A meta-analytic review. *Psychological bulletin, 144*(4), 394.

Luk, G., De Sa, E., & Bialystok, E. (2011). Is there a relation between onset age of bilingualism and enhancement of cognitive control? *Bilingualism: Language and cognition, 14*(4), 588-595.

Mackey, A. P., Hill, S. S., Stone, S. I., & Bunge, S. A. (2011). Differential effects of reasoning and speed training in children. *Developmental Science, 14*(3), 582-590.

Miller, E. K. (2000). The prefontral cortex and cognitive control. *Nature reviews neuroscience, 1*(1), 59-65.

Paap, K. R., Johnson, H. A., & Sawi, O. (2015). Bilingual advantages in executive functioning either do not exist or are restricted to very specific and undetermined circumstances. *Cortex, 69*, 265-278.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of experimental psychology, 18*(6), 643.

Valian, V. (2015). Bilingualism and cognition. *Bilingualism: Language and cognition, 18*(1), 3-24.

Van den Noort, M., Struys, E., Bosch, P., Jaswetz, L., Perriard, B., Yeo, S., . . . Lim, S. (2019). Does the bilingual advantage in cognitive control exist and if so, what are its modulating factors? A systematic review. *Behavioral Sciences, 9*(3), 27.

Woumans, E. (2015). *Effects of bilingualism on cognition.* Ghent University.

Xie, Z. (2018). The influence of second language (L2) proficiency on cognitive control among young adult unbalanced Chinese-English bilinguals. *Frontiers in psychology, 9*, 412.

Zied, K. M., Phillipe, A., Karine, P., Valerie, H.-T., Ghislaine, A., & Arnaud, R. (2004). Bilingualism and adult differences in inhibitory mechanisms: Evidence from a bilingual Stroop task. *Brain and cognition, 54*(3), 254-256.