



## Relation between creativity, executive functions and bilingualism

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### Abstract

This paper discusses the association between bilingualism and creativity considering the contribution of executive functions in this relationship. The studies which investigated the relationship between bilingualism, creativity and executive functions are reported. In the psychology literature, divergent thinking and creativity are synonymous concepts (Guilford, 1967). Previous research findings indicate that bilingual individuals outperform monolingual participants in divergent thinking tasks. Most studies compromise the positive impact of bilingualism on figural creativity, whereas there are some controversial findings in bilingual advantages on verbal creativity. Those studies that control bilingualism (L2 proficiency) found that bilingualism and verbal creativity are positively associated. Bilingualism and executive functions are also positively related. Some studies demonstrate a negative relationship between bilingualism and executive functions which may result from not controlling L2 proficiency over a standardized measure. The previous findings declared a positive relationship between creativity and executive functions. Most of the studies only use the inhibitory control subcomponent of the executive functions. Few studies investigate the relation between working memory and cognitive flexibility, and creativity. Likewise, there needs to be further examination on the relationship between specific subcomponents of executive functions and specific creativity types (like verbal and figural).

*Keywords:* creativity; bilingualism; divergent thinking; executive functions; childhood

### 1. Introduction

Creativity is defined as producing novel ideas or making new combinations from pre-existing concepts or ideas (Simonton, 2008; Sternberg, 2001). Also, Creativity is considered as having original and functional outcomes; besides, creative products need to be different from the majority of produced outcomes (Leikin, 2009). In the literature, divergent thinking is mostly used interchangeably with creativity, which refers to original and alternative responses to the problems (Guilford, 1967). According to Guilford, divergent thinking has four subcategories: fluency, flexibility, originality, and elaboration. Fluency indicates the number of divergent answers produced toward the specific problem. Flexibility corresponds to categories of given solutions; as well as how many different categories are made by individuals. Originality on the other hand, indicates the diversity of given answers toward a specific problem between each answer; how the number of offered different solutions divergent from

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each other. The more unusual ideas would be estimated as the original. Last, elaboration refers to how detailed participants respond to a question; and how many details the answers include, as well as how elaborated illustrations are created for responses. Many studies investigate whether there is a relationship between creativity and bilingualism for diverse age groups considering environmental, migration-related, educational, and familial factors (e.g., Adi-Japha, Berberich-Artzi, & Libnawi, 2010; Lee & Kim, 2010; Leikin & Tovli, 2014; Kharkhurin, 2007). Therefore, studying the effects of bilingualism has a significant value for understanding the impact of being bilingual on cognitive-developmental processes. Most of the studies found a positive relationship between creativity (as a cognitive process) and bilingualism (Ricciardelli, 1992; Kharkhurin, 2010; Madhav and Anand, 2012). However, as we mentioned above, there are several types of creativity that need to be taken into consideration. One other way to categorize types of creativity is depending on the novelty of the problem/task and solution. According to this categorization there are two types of creativity: (1) proactive creativity and (2) reactive creativity (Kaufmann, 2003). Proactive creativity refers to finding novel solutions to familiar tasks (e.g., problem-solving tasks) and reactive creativity occurs in a novel problem situation and novel solution producing, which is the category that needs more creativity (Kaufmann, 2004). Moreover, there is a basic way to categorize creativity types as verbal and non-verbal creativity. This paper will base the arguments depending on these two types of creativity. On one hand, verbal creativity abilities correspond to originality, novelty, and fluency in the generated narrations. On the other hand, figural and imaginary creativity are types of nonverbal creativity. Figural creativity includes lines, curves and simple drawing, participants are allowed to draw what they imagine (Kim et al., 2006). To complete figural creativity tasks there is no need to have prior knowledge which is not interpreted by linguistic and verbal capacities, cultural, and environmental background (Kharkhurin, 2010a). Additionally, executive functions (EF) are associated with creativity (Krumm et al., 2018; Zabelina et al., 2019).

## 2. Bilingualism and Creativity

There is a great body of literature on whether bilingualism has cognitive advantages or burdens (for review, Adesope, Lavin, Thompson, & Ungerleider, 2010). According to previous literature, bilinguals outperform monolinguals on cognitive functions (Bialystok, 2005). Many studies conducted to investigate the contribution of bilingualism to cognitive functions; those studies proved that bilingualism is related to creativity (Hommel et al., 2011; Kostandyan & Ledovaya, 2013; Madhav & Anand, 2012), problem-solving (Bialystok, 2006; Cushen, 2011; Leiken, 2020), and EF (Bialystok & DePape, 2009; Carlson & Meltzoff, 2008; Klein, 2015) as cognitive function creativity was found to be positively associated with bilingualism (Wang & Cheng, 2016).

Kharkhurin's (2010) study shows that bilingualism and higher creativity performance are positively associated; in the study, there are two groups of bilingual and monolingual participants. The first comparison includes L1-Russian and L2-English bilinguals and L1- English monolinguals both living in the US, while the other comparison group includes L1-Farsi and L2-English monolingual and L1-Farsi monolinguals living in the UAE. They use the biographical questionnaire to determine the acquisition of L1 -Farsi or Russian and L2- English. Participants have received a standard picture naming task to measure L2- English proficiency. Participants, who have higher proficiency in both languages, had taken divergent thinking tasks (the Abbreviated Torrance Test for Adults (ATTA; Goff & Torrance, 2002). ATTA includes verbal and figural creativity tasks that assess creativity through four subcomponents: flexibility, fluency, originality, elaboration (Goff & Torrance, 2002). In the study of Kharkhurin (2010a), there are two types of factors that predict the creativity scores which are generative and innovative capacity. In the study, fluency and flexibility reflect generative capacity, while the measure of originality represents innovative capacity. The results of the study demonstrate

that bilinguals in both conditions have higher generative capacity compared to L1 speaking monolinguals. Having high generative capacity means combining unrelated, unusual ideas and concepts, considering a component of creativity. This study is a very convenient example for testing whether there is a contextual difference between being bilingual among different cultures. It is important to mention that they indicate the positive relationship between bilingualism and creativity regardless of different language groups and cultural backgrounds. All bilingual groups were better than monolinguals on creativity tasks but comparing L2- English speaking participants in the US and UAE shows that bilinguals who live in L2 dominant society have slightly higher scores than bilinguals who live in the L1 dominant society. The researchers suggest that the differences may not yield from bilingualism but cultural background.

Most of the studies in this field use verbal and figural creativity and related tasks to compare bilinguals' and monolinguals' creativity to investigate whether there is an advantage of bilingualism on creativity (Kharkhurin & Altarriba, 2016; Kostandyan & Ledovaya, 2013).

In a meta-analysis study, Dijk et al. (2019) reviewed 13 studies about bilingualism and creativity; those studies mainly include university students and rarely children aged between 4 to 11. These studies measure creativity with verbal, figural, and mathematical creativity types and problem-solving tasks. For kindergarteners, bilingualism and problem-solving test were not related while bilingualism and mathematical creativity were associated. The findings on figural creativity and bilingualism advocated previous literature. Both adult and children studies show that bilingual participants had better performance on figural creativity. Likewise, reviewed studies demonstrate that bilinguals perform better on verbal creativity than monolingual participants. The studies reviewed on this metanalysis state that bilinguals have better scores on both verbal and non-verbal creativity. As stated in the article, both bilingual adults, children, and infants have higher creativity scores on related tasks than monolingual peers. These findings support the positive relationship between bilingualism and creativity. Dijk et al, (2019) explain the bilingual advantage on creativity through the situated-embodied cognition approach. The cognitive benefits of bilingualism lead to better creativity performance of participants. Overall, bilingual individuals outperform monolinguals on different creativity measures because bilinguals have a higher generative capacity and cognitive abilities.

Previous findings show a relation between bilingualism and different types of creativity (Kharkhurin, 2010). It appears that previous research builds consensus about bilingual advantages on non-verbal creativity such as figural and mathematical creativity (Leiken, 2013; Kharkhurin and Wei, 2015). For example, Leiken (2013) examined bilingual advantage on mathematical and non-mathematical creativity by comparing L1-Hebrew L2-Russian bilingual and L1-Hebrew monolingual preschoolers from bilingual and monolingual preschools. The participants completed pictorial solution tasks and equal numbers tasks that need creative problem-solving skills. Results indicated that bilingual children had better performance on non-verbal creativity. Also, early bilingual education seems advantageous for mathematical creativity. The bilingual children from the bilingual preschools show slightly better creativity types than bilingual children from monolingual preschools. The study is a good reminder of the importance of considering preschool education, whether bilingual or monolingual, while studying a young bilingual sample.

An early study claims both verbal and non-verbal advantages of bilingualism; bilingual individuals reveal more creative (original and fluent) outcomes in figural and verbal creativity domains compared to monolinguals (Simonton, 2008). However, even though most researchers agree on bilingual advantages in different creative types, both verbal and non-verbal creativity (Lee & Kim, 2011; Madhav & Anand, 2012), some studies show monolingual advantage on verbal creativity instead of bilingual advantage (Kharkhurinb 2010b).

There are plenty of studies that show bilingual advantages on verbal creativity, in other words, bilingual individuals have better performance on verbal creativity tasks. For example, Ricciardelli (1992) demonstrates that bilinguals have more outstanding creativity scores on both verbal and nonverbal task domains. He reviewed 24 separate studies: 14 show bilingual superiority on verbal creativity tasks, and 12 exhibit bilingual advantages on nonverbal divergent thinking tasks. Moreover, recent research conveys that being balanced bilingual is advantaged on verbal and figural creativity domains; in other words, there is a positive association between L2 proficiency and figural and verbal creativity (Sampedro & Peña, 2019). They found that L1-Basque and L2-Spanish speaking bilinguals at early adolescence (age ranged 9-12) performed better at verbal and figural creativity tasks. L2 proficiency was an essential factor in predicting creativity performance in that experiment. As such, high proficient bilinguals display better performance in both figural and verbal creativity than medium-proficient bilinguals. The relationship between bilingualism and creativity has been found closely related to L2 proficiency. The degree of bilingualism or proficiency at L2 is a crucial predictor of the bilingual advantage of creativity domains; research infers positive relation between L2 proficiency and creativity (Lee & Kim, 2011; Wang & Cheng, 2016). Another study by Sampedro and Pena (2019) shows that low or moderate L2 proficiency would lead to worse performance in verbal creativity. Participants who have low and moderate L2 proficiency less succeed in verbal creativity tasks than monolingual and balanced bilinguals. To accurately investigate the effect of bilingualism on verbal creativity it is crucial to obtain the level of bilingualism. There might be a positive relationship between L2 proficiency and verbal creativity instead of the self-reported level of bilingualism.

Even though studies mentioned above instantiated bilingual advantaged in verbal creativity, specific research findings disagree with that idea. Some reasonable explanations attribute that to the fact that monolinguals have better verbal abilities than bilinguals due to bilingual disadvantages in speech production. Ivanova and Costa (2008) showed that monolinguals are faster in the verbal naming task than bilinguals. In that study, bilinguals were tested in their dominant L1 and proficient L2, but monolingual participants outperformed both trials of bilinguals. Hence, some expectations about bilingual individuals will have lower performance on verbal creativity tasks due to poorer bilingual performance on verbal cognitive tasks. In a study, Kharkhurin (2010b) tested that hypothesis; they recruited bilingual (L1- Russian; L2-English) and monolingual (L2 -English) adult participants. All participants get Picture Naming task as a productive vocabulary test and Abbreviated Torrance Test for Adults including verbal and non-verbal creativity tasks. The findings indicate monolinguals get higher scores on the vocabulary task. Parallely, they perform better at verbal creativity tasks than bilingual participants. On the other hand, the same study duplicates previous research findings that bilingualism is positively related to figural creativity. In that study, bilingual participants show higher performance on figural creativity tasks than monolinguals (Kharkhurin, 2010b).

In the creativity literature, there is an important point to note: L2 proficiency highly matters when studying bilingualism. The divergence between research findings might arise from not taking L2 proficiency into account, which is a gap in the literature.

### **3. Bilingualism and Executive Functions**

Executive functions (EF) refer to processes that control reflexive thoughts, cognitive abilities, behaviors, and attention processes (Diamond, 2013). Inhibitory control, working memory, and cognitive flexibility are three subcomponents of the EFs (Garon et al., 2008). EFs are one of the most studied topics; what functions affect EFs and what functions affect EFs are highly interested in developmental psychology. Several research investigated the association between bilingualism and EFs. Studies exhibit two different results; some argue that bilingualism positively affects EFs; on the other hand, some results show a negative relation between bilingualism and EFs.

A study that compares Spanish-English bilingual preschoolers' EF with monolingual English children found that bilingual children outperformed on EF tasks when SES and parental education were controlled (Carlson & Meltzoff, 2008). Another early study decelerated better performance on Dimensional Change Card Sorting (DCCS) task for bilingual children, which is a cognitive flexibility task for preschool children (Bialystok, 1999). Children who correctly sort the cards both in a way to instructed and after the instruction switches successfully pass the task (Zelazo et al., 2003); in other words, they should apply inhibitory control and cognitive flexibility. According to Bialystok (2001), bilingual people practice inhibitory control when choosing the appropriate language and inhibiting non-relevant ones. This daily practice might cause an advantage in inhibitory control. Nonetheless, not all findings justify bilingual advantage on the EFs. A recent study with a large sample including 11,041 participants finds no significant association between bilingualism and better EF scores. They use 12 different EF measures with monolingual and bilingual participants including Double Trouble, Spatial Planning, Odd One Out, Grammatical Reasoning, Feature Match, Polygons, Digit Span, Rotations, Token Search, Paired Associates, Spatial Span, Monkey Ladder. The results show that bilinguals don't have better scores on 11 different EF tasks (Nichols et al., 2020). In this large-sampled study, researchers only used detailed demographic questionnaires to determine bilingual participants; there were no standardized language tests. Overall, there are some controversial findings in the bilingualism and EFs literature. Even though some recent research shows bilingual disadvantages on EFs, the majority of the studies still show a positive relation between bilingualism and EFs. To reduce this controversy among literature, L2 proficiency should be too into consideration. The differences among results may cause participants' level of bilingualism.

#### **4. Creativity and Executive Functions**

Creativity refers to combining unfamiliar concepts and avoiding common concepts. Generating creative ideas related to subcategories of EFs are working memory, inhibitory control, and cognitive flexibility. Studies show a positive association between divergent thinking and inhibitory control tasks (Groborz & Necka, 2003). Most of the studies investigating EF and creativity assess only inhibitory control. In the mentioned literature, cognitive flexibility is the second most studied EF subcategory, and the least studied component is working memory. Even though the effect of working memory on creativity is an understudied topic, Dreu et al. (2012) study has investigated the relationship and they report a positive correlation between working memory and creativity on fluency and originality subcategories. Research conducted structural equation modeling to determine which EFs contribute the creativity; alternate uses task was used, which is a kind of verbal task. The model revealed that working memory and inhibitory control predict creativity, but they have not found any significant impact on cognitive-flexibility (Benedek et al., 2014). A more recent study replicates Benedek et al. (2014) research findings; Zabelina et al. (2019) conducted a study with an adult sample (age range from 19 to 47). They administered a standardized verbal and figural creativity task and EF tasks for working memory, inhibition, and cognitive flexibility. Results showed that EFs are significantly related to creativity scores, especially better working memory capacity, predict higher creativity in the fluency category (Zabelina et al., 2019). However, researchers do not investigate the specific effects of EF components on different types of creativity scores (verbal and figural). Most of the studies use only a dimension of the EFs, which is generally an inhibitory control component (Edl et al., 2014; Benedek et al., 2012; Cassotti et al., 2016). The contribution of working memory to creativity is understudied, but few research findings have shown that working memory significantly predicts creativity scores. (Drue et al., 2012; Benedek et al., 2014). It is essential to investigate the impact of working memory on verbal and non-verbal creativity types differently. In the literature, different creativity tasks were used. Therefore, different results may arise. For example, Zabelina et al. (2019) use figural creativity

tasks in their research design, and they found a significant impact of working memory on creativity. However, Leiken's (2020) study does not find any effect of working memory on creativity when using non-figural creativity tasks. Starting from the point of view, differences in the effects of working memory on figural creativity might result from using different tasks.

## 5. Conclusions

In this paper, relations between creativity, bilingualism, and EFs are reviewed based on previous literature. The reviewed studies indicate a line between bilingualism and creativity. To understand how this relationship settles needs to examine related components like executive functions. Many of the studies defend bilingual advantage on EFs, and some other research points to the positive relationship between creativity and EFs. Therefore, it is essential to investigate the role of EFs to make clear the association between bilingualism and creativity completely. The EFs might mediate on this association. On this point, different subcomponents of EFs should take into consideration. There might be diverse different relationships between different types of creativity (e.g., verbal, non-verbal) and subcomponents of EFs.

In the bilingualism and creativity literature, the considering level of bilingualism is crucial. Some studies show a medium level of bilingualism restrain better performance on creativity tasks (Leiken, 2014). Therefore, L2 proficiency is a more accurate predictor of creativity instead of self-reported bilingualism. According to Threshold theory, to obtain cognitive advantages of bilingualism, the person needs to be a balanced bilingual who react to at least two thresholds out of three levels (Skutnabb-Kangas 1981). The early L2 acquisition would predict high L2 proficiency, herewith researching the association between being early balanced bilingual and having better creativity performance is a new field to conduct further studies.

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