

Bilingualism and its contribution to Executive Function

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Abstract:

The goal of this paper is to identify a relationship between language proficiency(LP) and executive function(EF) within both monolinguals and bilinguals. There's an existing debate that focuses on research related to the benefit of having two active linguistic systems that consistently compete to assume dominance. As a function of the necessary maintenance of the two language processing domains, bilinguals are expected to exhibit increased executive function when compared to monolinguals on tasks that measure EF. To properly identify relationships between EF and LP, studies were designed to analyze and collect information in respect to the inner domains of EF and their correlations to each individuals proficiency within two languages. Within study one, 810 participants take part in a self-report questionnaire that measures beliefs and perceptions related to LP and EF. Study two focuses on a more direct approach to the assessment of language proficiency, where participants from study one take a standardized assessment for English and English-Spanish speakers. Findings from study two should correlate well with LP indications from study one, where previous EF measures from study one can be used to find any relationships there might be between variations in LP findings from the standardized language assessment. Lastly, participants from study one and two take part in a series of tasks in study three that seek to measure inhibitory control, working memory, and cognitive flexibility in an effort to find correlations between EF findings and LP measures from study two. This research should help us better our understanding of the benefits tied to bilingualism and what they might suggest for language curriculums and possible improvements.

Keywords: Executive function, language proficiency, bilingualism

Bilingualism and its Contribution to Executive Function

An elaborative understanding of the structures that contribute to executive function is necessary for further improvement in areas where optimizations can help students and independent learners reach their goals more efficiently. Assuming that the acquisition and use of a second language is beneficial to EF, then improvements in everyday activities should be expected as a result of the large domain that EF happens to cover. Used as an umbrella term for top-down cognitive processes, executive functions refer to a collective joint of processes that involve inhibition, working memory, and flexibility in the shift of cognitive tasks (Minna et al., 2018). In theory, during a bilingual's production of speech, both fluent language systems become active and influence verbal decision making (Ross & Melinger, 2017). Since both linguistic systems are active at the same time, the production of one word should elicit competitive behavior between lexical alternatives. To prevent the risk of interference between the two systems, a level of efficiency must be met where unnecessary terms can be inhibited and sets of lexical terms can be switched across without creating a collision. Additionally, within fluent bilinguals, a consistent moderation of activation levels between the two languages would be necessary for choosing the appropriate choice of words for the correct context (Minna et al., 2018). It's in this sense that executive function processes are exercised and trained, where repeated uses of task-switching actions, including language-switching, aid in further EF development.

Despite the proposed advantages acquainted with second language acquisition, another perspective argues that there's a potential disadvantage associated with bilingualism. Since both language systems are simultaneously active within a fluent bilingual, there exists a potential problem of conflict that isn't available to the monolingual speaker. During the intake of verbal

information, the bilingual speaker needs to add a dimension of selection to the typical sequence of linguistic processing. This sequence includes dimensions such as register, collocation, and synonym (Bialystok, 2011). Research on nonverbal tasks has concluded that a general-purpose executive control system is used for selection and conflict resolution, so the EF system should seemingly become active to resolve conflicts created by the joint activation of the two lingual systems(Bialystok, 2011). Additionally, if the EF system is ordinarily recruited in lingual processing, then the relationship between the two should improve with repeated practice, resulting in a more proficient selection of the target language. In this manner, fluent bilinguals should be more proficient at verbal tasks involving EF compared to bilinguals with less proficiency as a result of repeated practice. Additionally, monolinguals should likely exhibit a slight advantage when it comes to verbal tasks that require bilinguals to resolve conflicts between the two linguistic systems using EF. However, as a function of increased use of executive control function, bilinguals should have an advantage when it comes to nonverbal executive control tasks.

Executive Control and Measures

To support the claim that language proficiency and second language acquisition is supplemental to cognitive processes involving EF, demonstrations involving EF are needed to describe any relationships that might be found. Since EF covers a wide domain of top-down cognitive processes, specific areas should be assessed to collectively determine variations of EF between individuals with varying degrees of LP. A general agreement amongst researchers has operationalized EF as a function of three core components; inhibition, working memory, and

cognitive flexibility(Diamond, 2012). From these three core components, higher order EF's, such as reasoning and problem solving, can be abstracted and measured.

Inhibition: Inhibition refers to an individual's ability to control attentiveness, behavior, and strong internal predispositions. Without an extent of inhibition, we'd become a victim to the constant stimuli within our environment. At the level of perception, inhibitory control enables us to select and focus on which stimuli we'd like to attend to or suppress(Diamond, 2012). In relation to bilingualism, inhibitory control allows us to refrain from committing to the non-target language when it's inappropriate for the given social context. Similarly, someone's ability to fight temptations and persevere on a task can be reflective of that individual's EF. Since we're trained to abstract meaning from words that we see, we tend to ignore superficial characteristics of words such as font style or ink color. For this reason, tasks that measure a participants' ability to refrain from obtrusive stimuli, while completing a given objective, can be used to assess varying levels of inhibition between other participants. A popular assessment of inhibition is the Stroop task, where words can be congruent("blue" in blue ink) or incongruent("red" in green ink) with the ink they're printed in(Duñabeitia et al., 2014). When participants are asked to report the color of the ink, they're forced to inhibit reinforced tendencies that work against their decision-making skills. Proficiency within this task is measured as a function of latency and the total number of errors. Thus, the Stroop task can be used, with validity ensured, to operationalize inhibition in an analytical approach to measuring EF.

Working Memory: Working memory(WM) is an important component of EF that involves an individual's ability to withhold information in the mind and mentally work

with it to complete some objective. WM is an important aspect of perception, where incoming stimuli are first withheld and then manipulated during the process of interpretation. Unlike short-term memory, working memory relies on the dorsolateral prefrontal cortex, which becomes active when withheld information is manipulated (Diamond, 2012). When measuring WM, it's important to account for the bi-directional relationship between inhibition and WM. For example, inhibition is needed during the use of WM, where ideas and facts need to be focused on independently before they collectively form some sense of meaning; where inhibition prevents unnecessary stimuli from interfering with existing thoughts and facts that are being manipulated. On the other hand, WM is needed for the storage of information during the process of inhibition, where concepts need to be withheld and evaluated before deciding what needs to be inhibited (Diamond, 2012). Then, to properly measure WM, participants should take part in an activity that involves both the manipulation and retention of given information, where the influence of inhibition should also be considered. The Hearts and Flowers task is an assessment that requires participants to remember two rules; press on the same side as the stimulus for stimulus one, and press on the opposite side of the stimulus for stimulus 2. This task requires participants to mentally withhold instructions, and then manipulate or use that information to carry out the correct response (Diamond, 2012).

Cognitive Flexibility: Cognitive flexibility (CF) is an essential component of EF and LP, where the term refers to an individual's ability to quickly and flexibly adapt to behavior to changing situations (Davidson et al., 2006). Said differently, cognitive flexibility refers to our ability to rearrange our perceptions to find new interpretive frameworks and

approaches to problem or concepts. As a consequence of consistently switching between two languages, bilinguals are a suspect of enhanced flexibility when it comes to adaptation and re-interpretation. Commonly, CF is investigated using task-switching and set-switching tasks(Diamond, 2012). A popular task used for assessing CF is the Dimensional Change Card Sort(DCSS). Within this task, individuals are shown two target cards and asked to sort a series of cards with respect to an initial dimension(e.g., color) and then a secondary dimension(e.g., shape)(Zelazo et al., 2014). Essentially, the goal of the task is to measure an individual's ability to quickly adapt to changing contexts in order to successfully sort an object according to the appropriate construct. This task can be used to compare CF between monolinguals and bilinguals, where bilinguals should be more efficient as a function of their experience with language-switching.

The Present Study

This study aims to retest typical methods used in the analysis of executive function and its relationship to language proficiency. Methods will be designed around the analysis of correlations between EF and LP, where popular tasks for measuring EF will be used to improved accuracy when results are used and compared to similar studies of LP and EF. Currently, issues within the topic of research are contributed to unaccounted variables and variations in methodologies. Factors, like age differentials and inconsistent use of methodology, make it difficult for meta-analyses to draw conclusions around the topic. In response, the methodology within this study will be tailored towards young adults, where we'll use popular and valid measures to ensure efficiency when comparisons are made.

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