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RESEARCH ARTICLE

The Relationship Between Cognitive Control Capacity and Language Dominance Among Malay Bilinguals

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ABSTRACT

A growing number of research has suggested that bilingualism could be related to enhanced cognitive control functions (Bellegarda & Macizo, 2021), because of frequent interference suppression of the first language when a bilingual speaker chooses to speak in the second language and vice versa. Nevertheless, the relationship was not shown in some studies, which raises various questions regarding previous findings. Hence, more studies are done to explore other facets of bilingual speaker's experience that could modulate the cognitive control functions. Accordingly, the bilingualism threshold is examined to investigate the bilingual benefits. It is suggested that bilingual benefits are not just about knowing two languages, but more so into the usage of the languages possessed. Hence, some studies claimed that balanced language dominance would have better cognitive control capacity. This is a result of the continuous practice of suppressing one language over the targeted language. Therefore, there is a need to look at how language dominance could be related to cognitive control capacity as language dominance may impact the frequency of switching as well as activation of the two languages. This study reports the findings of the relationship between cognitive control capacity and language dominance of Malay bilinguals. The participants of this study were 69 balanced bilinguals and 74 Malay-dominant bilinguals. The Bilingual Language Profile was adopted to measure the language dominance of the participants of this study. Cognitive control capacity of the participants was measured with the Stroop Task. Through a Pearson-correlation analysis, it was found that there is a significant relationship between language dominance and cognitive control capacity. Thus,

the findings of this research as in line with previous literatures where language dominance of a bilingual is related to enhanced cognitive control functions.

Contribution/Originality: This study significantly advances the existing literature on bilingualism and cognition. By focusing on Malay bilinguals, a previously understudied population, this research offers valuable insights into the bilingual experience in Malaysia, a country with a rich tradition of bilingualism.

1. Introduction

Malaysia has held the history of bilingualism since before independence in 1957. In the earlier days, Madrasah and other Islamic school were the earliest type of education. Initially, these schools use Malay or Arabic language as the medium of instruction. However, after the British colonization, secular schools were introduced by the British government. This led to the development of vernacular schools for the betterment of the Malay, Indian and Chinese communities. The British started to introduce English to these schools as their focus was to promote English medium schools. English language became the medium for the curriculum of these schools and has led to English language be the inter-ethnic communication for the rich (Jones & Ozóg, 1993).

Hence, even though Malay language was vital and used by many as a language of daily communication, English was used as the medium for international communication, which led to a more concrete setting of the bilingualism landscape in Malaysia. Bilingualism was seen as an important factor in national unity and to ensure national development (Subramaniam, 2007). Even though the Malay language was the national language, the English language was the medium of instruction in schools; hence the English language gained a position of prestige as it considered crucial in education and career development and this trend has been sustained till today. Indeed, the history of Malaysian schools is the one that shapes today's Malaysian education system that leads to the bilingualism landscape in Malaysia.

Recent studies argue that almost all citizens have been brought up with two languages simultaneously from an early age (Fatin Nadiah & Khazriyati, 2023; Rahman & Singh, 2021). Being a multi-racial country, the language profile of Malaysians may be very diversed as suggested in Fatin Nadiah and Khazriyati (2023) but being exposed to the language is simply a cover definition and often times, bilinguals may not form a homogenous group as they may differ in terms of language experience, preference and use of the respective languages which may in turn be related to their language dominance and language proficiency as discussed in Fatin Nadiah and Khazriyati (2023). Because of this diversity, which is not well investigated, the current study examines relationship between language dominance and cognitive control capacity as the bilinguals can vary substantially.

The capacity of the brain to attend to incoming information is limited at any one time and it is often referred to as cognitive control capacity or executive functions of the brain. Cognitive control capacity involves selection and prioritization of information to reach the capacity limit of a conscious mind (Wu et al., 2019). That is why, cognitive control plays a crucial role in selecting and prioritizing important information and to suppress or ignore any unwanted information. Simply put, without cognitive control, one will not be able to suppress any unwanted information and maintain a goal at hand. Thus, there is a

growing number of studies researching into efforts that can be done to enhance one's cognitive control capacity, and one of them is examining the benefits of being bilingual.

Bilinguals have the ability to choose one language over the other in a specific context in their daily life. For example, when a Malay bilingual wants to speak in English, their Malay language is suppressed as to not disturb the understanding of their English utterances. As a result, this continuous practice brings out the idea of bilingual benefits in cognitive control capacity (Feleke, 2020). Indeed, there are research that have found evidence supporting the bilingual advantage in inhibition and switching (e.g., Bellegarda & Macizo, 2021; Planckaert et al., 2023). Based on the mechanism of bilingualism, it is common for the bilinguals to switch the languages back and forth in a conversation, which leads to the assumption that bilingualism could enhance general task switching ability.

Besides that, many studies have shown the influence of bilingualism on cognitive control capacity (Jiang et al., 2024; van den Noort, 2019; Xie & Zhou, 2020). As explained previously, cognitive control deals with processes that allow information processing and behaviour to vary adaptively depending on current goals. These processes come in line with the bilinguals' language processing (i.e., a Malay bilingual can choose to speak English language and suppress Malay language when the situation requires them to do so). A bilingual's brain can adapt to the situation by switching to the required language when one language is targeted over the other.

Gosselin and Sabourin (2023) suggest that those bilinguals who use the languages they possess interchangeably showed the most competent performance than the bilinguals who do not. Therefore, some studies have attempted to investigate the precise relationship between bilingualism and its benefits on their cognitive control capacity. Tao et al. (2015), in adopting the threshold theory proposed by Cummins (1979) suggested that it may be important to consider whether the bilingual has surpassed a particular threshold to obtain effects from the bilingual benefit. That is why, this current study aims to provide insights into the degree of bilingualism through language dominance that can give benefits to the bilinguals in enhancing their cognitive functions.

1.1. Research Objective

The purpose of this research is to investigate the relationship between language dominance with cognitive control capacity.

With the general objective mentioned above, this study aims to address the following specific objectives:

i. Is there any significant difference of language dominance scores between balanced bilinguals and Malay-dominant bilinguals?
ii. Is there any significant relationship between language dominance and cognitive control capacity?

2. Literature Review

2.1. Language Dominance and Cognitive Control Capacity

To know more than one language has been a fascinating ability that researchers found intriguing. Processing one language is already a challenge, let alone processing two

languages. That is why, linguists have suggested that bilingualism enhances one's cognitive control capacity (Zunini et al., 2019). Cognitive control, or executive functions, is defined as one's ability to a goal-directed behaviour, from perceiving to executing, decision-making to planning and problem-solving to language processing. According to Ritz et al. (2022), cognitive control is a construct that allows our brain to filter out irrelevant information such as interference suppression and maintaining the goal at hand. This is in line with the mechanism of bilingualism. A bilingual needs to select a targeted language in respond to a particular situation and they need to suppress any interference from the other language. For example, a Malay bilingual needs to suppress their L1 (i.e., Malay language) when they are speaking in English.

Hence, there are many studies done in investigating the advantage of being a bilingual to their cognitive functions (e.g., Bialystok & Craik, 2022; Carter et al., 2023; Ware et al., 2020). Kalamala et al. (2021) state that due to bilinguals' language processing that are always competing, the bilingual brain depends on executive functions to maintain the balance between languages. Thus, this constant practice strengthens their executive functions. Moreover, previous research has found advantages for bilingual on attention control tasks (e.g., deMeurisse & Kaan, 2023) and tasks that require the switching of mental sets (e.g., Yang et al., 2017). Plus, the process of selecting a word has caused interference between the two different language systems to be activated and the right word-selection is facilitated through the mechanism of cognitive control (Rodriguez-Fornells et al., 2006). Thus, this dependency has led to positive effects on the cognitive control functions of bilinguals.

However, before finding the relationship between bilingualism and cognitive control capacity, it is a need to first understand the concept of bilingualism that could contribute to one's cognitive control capacity. When it comes to bilingual benefit, the degree of bilingualism is questioned through language dominance. This is because bilingual works in a continuum dimension, which means that a speaker who is more dominant in one language over the other can be called a bilingual and a speaker who is fluent in both languages can also be called a bilingual. That is why, language dominance is deemed as an important factor in determining the threshold theory proposed by Cummins (1979) (as cited in Rolstad & Macswan, 2014). These differences led to an in-depth investigation into the aspects of bilingualism and cognition. Hence, this current study aims to investigate the bilingual benefit through balanced and Malay-dominant bilinguals which will further discussed through language dominance.

Wei (2007) defined balanced bilinguals as "someone whose mastery of two languages is roughly equivalent" while dominant bilinguals as "someone with greater proficiency in one of his or her languages and use it significantly more than the other languages (s)." Echoing the need to have in-depth exploration into language dominance by Silva-Corvalán and Treffers-Dallers (2015), this study investigates language dominance as one of the variables in investigating bilingual benefit. This is because Grosjean (1998) proposes that conflicting results in the aspect of bilingual benefit could be lessened if more attention was given into the concept of bilingualism. However, there are researchers who oppose the need to investigate language dominance as a useful construct to explain bilingual benefit (De Houwer, 2011; Meisel, 2007). They claimed that language dominance changes over the lifespan of a bilingual and language dominance is about one's linguistic knowledge, not related to language processing.

Yet, Vera et al. (2023) claim that the linguistic knowledge may still reflect the level of knowledge representation which is the language competence. They found that in terms of the mean length of utterance (MLU), the influence of Cantonese in English occurs more among Cantonese-dominant compared to other bilinguals. This shows that language dominance does play a role in understanding the bilinguals' language control processes. Previous studies (e.g., Carroll, 2015; Salwei & Diego-Lázaro, 2021) show that the amount of input and frequency of use are important in determining the bilingual's language dominance. According to Silva-Corvalán and Treffers-Dallers (2015), the language that bilingual uses frequently is called the stronger language while least frequent used language is the weaker language. Stronger language tend to affect the weaker language more and not vice versa (Argyri & Sorace, 2007). Calabria et al. (2019) propose that bilinguals tend to 'fill in' the weaker knowledge with the knowledge they have on the stronger language.

Thus, the ability for the stronger language to fill in the gap provided by the weaker language as mentioned earlier requires a great deal of cognitive control to inhibit the unwanted words from the stronger language or to making sure the structure of the stronger language into the weaker language is correct. This shows that language dominance plays a crucial role in the bilingual language control processes as the existence of the effect of dominant language on the weaker language cannot be denied. However, if the usage of these two languages is balanced, the effect might lessen as there is no weaker of stronger language. According to Landry (1974), the fair usage of both languages leads to balanced bilinguals to be better at divergent thinking compared to dominant bilinguals. In addition, this balanced usage frequency of languages in daily life helps the balanced bilinguals to have more opportunities to practice selective attention and inhibition as both languages are mentally activated (Guttentag et al., 1984, as cited in Bialystok, 2001). That is why, this study investigates balanced bilinguals and Malay-dominant bilinguals as the language process is different when the frequency of language use is different.

2.2. Threshold Theory

Threshold Theory is a theory that summarizes the relationship between cognitive benefit and the different degree of bilingualism which was first proposed by Skutnabb-Kangas (1977) and Cummins (1979). They suggest that research on bilingualism and cognitive benefit should be relying on two thresholds. The first threshold is the extent a child should achieve to avoid negative consequences of bilingualism which means that a bilingual should achieve the right level of linguistic competence to avoid any confusion or difficulties in processing two languages at the same time. On the other hand, the second threshold is the level a bilingual child should acquire to gain the positive cognitive benefit of bilingualism. This signifies that a bilingual should have a balanced usage of the two languages in their daily life which will positively affect the bilingual's cognitive growth.

2.3. Measuring Language Dominance

Language dominance has been discussed even in one of the earliest studies on bilingualism (Ronjat, 1913 as cited in Byers-Heinlein & Lew-Williams, 2013). In more recent studies (e.g., Komeili et al., 2023; Salwei & Diego-Lázaro, 2021), language dominance is still perceived as an important issue as their studies reveal that even though a bilingual child is being exposed simultaneously to two languages since birth,

they will eventually have different abilities in the two languages which would result to one language being more dominant than the other. The aspect of language dominance can be perceived from two viewpoints; the first being the link between language dominance and language use; where bilinguals may have a preference to use one language over the other. The second viewpoint is illustrated through the connection between linguistic development and language dominance that explains why some bilinguals are more advanced in one language than the other (Hamann et al., 2019).

Argyri and Sorace (2007) propose two key factors in addressing language dominance which are the exposure to and use of languages. These two factors are crucial as when it comes to understanding language dominance, these two keys need to work concurrently. Let us first consider Malaysians who have been exposed to Malay and English language since birth. If language dominance is measured only on the basis of exposure to the two languages, the question of language preference will rise. That is why, the use of the languages in a bilingual's everyday life should also be addressed as one might favour one language over the other. These elements that language dominance covers are the reason why language dominance should be considered as the first highlighted property of the mind.

Due to the complexity of defining language dominance and the apprehension of language dominance as a multidimensional construct, Schmid and Yilmaz (2018) propose that language dominance need to be measured and validated as to investigate the effect of it on other variables. Bilinguals' language dominance is not just about dominance, but the factors underlying it. Defining bilingualism has to work in a continuum which is why understanding how a bilingual's brain works around the language dominance is not an easy task. Language dominance of a bilingual, especially Malaysian bilingual does not work in a black and white construct as they are continuously exposed to two languages and they are constantly pushed in using the two languages, but rather the measurement factors have to be highlighted as well. Hence, this study is interested in imparting the concept of language dominance of a bilingual through four factors which are language history, language use, language proficiency and language attitude.

These four factors can measure the language dominance of the bilinguals more precisely. The language history questions cover the language exposure for both Malay and English language among the bilinguals. This is the first key proposed by Argyri and Sorace (2007) while the language use factor explains the second key of language dominance. The question on proficiency when dealing with language dominance has been brought up by many studies (Hamann et al., 2019; Treffers-Daller & Korybski, 2015) which led to the third factor the language dominance scores, language proficiency. It should be noted that the language proficiency here is measured through a self-reported proficiency. The last factor in deciding the language dominance of the bilinguals is the language attitude. Language dominance deals with the bilinguals' personal experience of both languages. Hence, this language attitude factor will help to further identify the personal experience of the bilinguals. These four factors will help this study to fill in the gap through the use of Bilingual Language Profile (BLP).

3. Research Methods

3.1. Research Design

The present study employs a quantitative, causal-comparative research design to examine the relationship between language dominance and cognitive control capacity. Correlation research is instrumental in investigating the covariation of variables. The primary objective of this design is to identify and analyse the differences between groups of subjects in relation to the independent and dependent variables. Unlike experimental designs, causal-comparative research involves pre-existing groups defined by their characteristics. For this study, the two groups are balanced bilinguals and Malay-dominant bilinguals. Balanced bilinguals demonstrated advanced proficiency in both Malay and English, while Malay-dominant bilinguals exhibit fluency in Malay but not English. Given the distinct language proficiencies of these groups, a causal-comparative design is optimally suited to investigate the disparities between them.

3.2. Population, Sample and Sampling Technique

The population for this research is among the foundation students, aged 19 years old. The participants were selected based on quota sampling. This is because this research has a specific target which only involves balanced and Malay-dominant bilingual. Thus, through this sampling, it will ease the participant selection process that can be the representatives of the given population for this study. It is also important to be noted that all the participants are the same age as literature suggests that age is related to the executive functions (Motovylyak et al., 2022; Wang & Zhou, 2023). This means that if the age of the participants is not controlled, the data obtained might be hampered. 143 bilinguals were recruited for this study. A total of two groups which 69 and 74 participants per group respectively were formed: balanced and Malay-dominant bilinguals. Both the balanced and Malay-dominant bilinguals are the native speakers of Malay language and whose second language is English language.

3.3. Sampling technique

The quota sampling will be used in this study. This research has a specific type of target which only involves balanced and Malay-dominant bilinguals. Hence, this type of sampling will help the researcher to make principled decisions on selecting the right participants that can be the representatives of the given population for the study which will then help to answer the stated research questions.

To ensure a representative sample of Malay-dominant bilinguals, a preliminary screening process was conducted using the Bilingual Language Profile (BLP) and Bilingual Switching Questionnaire (BSWQ) on a pool of 300 potential participants. Based on the screening results, 69 balanced bilinguals and 74 Malay-dominant bilinguals were selected to participate in the study.

3.4. Instrument

To accurately categorise participants into balanced bilinguals and Malay-dominant bilinguals, the BSWQ was administered. This questionnaire, adapted from the Language Proficiency Scale (Paap & Greenberg, 2013) and the original BSWQ (Rodriguez-Fornells et al., 2006), assessed participants language experiences, proficiency and switching behaviours. Part 1 of the BSWQ focused on participants' exposure to English and Malay language, MUET band, Malay SPM grade, frequency of using the two languages, overall language abilities, and self-perceived language skills. These questions aimed to measure participants' predictive proficiency and gather detailed information about their language

acquisition. Part 2 of the BSWQ consisted of twelve items designed to psychometrically validate and assess four factors related to code-switching: 1) L1-Switch (tendency to switch to Malay), 2) L2-Switch (tendency to switch to English), 3) contextual switch (frequency of situation-specific switches), and 4) US (lack of awareness of language switches).

To assess the participants' cognitive processing speed and their level of cognitive control capacity, the Stroop Task was used. The Stroop Task is a task where participants need to identify the colour of the word and suppress the lexical meaning of the printed word. As suggested in previous studies (e.g. Mohamed Zied et al., 2004), the Stroop Task for this study was conducted in two languages (i.e., Malay language and English language) so as to avoid language effect on the Stroop Effect data and to increase the efficiency of the inhibitory mechanism. Hence, the task involved four colours and their respective colour names in English (RED, BLUE, GREEN and YELLOW) and Malay (MERAH, BIRU, HIJAU and KUNING). The colour words were presented in two conditions: 1) congruent and 2) incongruent. In the congruent condition, the colour matches the meaning of the word. For example, the word BLUE will be presented in blue. The incongruent condition involves presentation of mismatches between the colour and the lexical meaning of the word. For example, the word YELLOW might be presented in red. There were 144 trials: 72 congruent and 72 incongruent trials. The amount of congruent and incongruent trials are in equal proportion and randomly intermixed to increase the sensitivity of the task in detecting the role of monitoring (Costa et al., 2009). Each trial began with a fixation "+" for 200 ms. The stimulus appeared and remained until a response is recorded. The response is based on two elements which are Stroop Interference which occurs when the reading delays the time taken to focus on the colour and produces a response. Stroop Facilittation where a shorter time is observed when the stimuli is presented congruently (Thomas, 2011). The Reaction Time (RT) and the Correct Response from the Stroop Task are used for the data analysis.

The Bilingual Language Profile (BLP) is an instrument to assess language dominance of participants through self-reports (Birdsong et al., 2012). A BLP is used in this study to produce a continuous dominance score and a general bilingual profile considering a variety of linguistic variables. It offers a systematic means of conceptualizing and evaluating bilingual language dominance to meet the demands of standardization on measuring dominance. The two groups of participants (i.e., balanced bilingual and Malay-dominant bilingual) filled out the BLP survey which consists of a total of 50 questions that covers biographical information, language history, language use, language proficiency and language attitudes. For language history, the participants need to fill in points between the range of 0 to 20 and phrasal responses "Since birth" and "For long as I can remember" are worth 20 points. For the language use, participants need to fill in points between 0 and 10 for each question. The points for language proficiency and language attitudes are worth between 0 and 6. This instrument applies self-scoring questionnaire where the scores are automatically calculated online. It has a cut-off point where a score near to zero indicates balanced usage of the two languages a bilingual possesses while a more positive or negative scores reflect the dominant language of a bilingual. To control the sensitivity of the data, only the data of the Malay-dominant bilinguals are used for this study. Bilinguals who are English-dominant are not included in this study.

3.5. Data Analysis

The primary objective of this study was to examine the correlation between language dominance and cognitive control capacity in bilingual individuals. A quota sampling method was employed to select balanced and Malay-dominant bilingual participants.

Balanced bilinguals were identified as those who scored near zero on the Bilingual Language Profile (BLP), indicating a balanced proficiency in both languages. Conversely, Malay-dominant bilinguals were selected based on a more positive BLP score, reflecting a greater dominance in Malay.

To assess cognitive control capacity, all participants completed the Stroop Task. An independent samples t-test was conducted to confirm a significant difference in language dominance scores between the balanced and Malay-dominant bilingual groups. Following this, a Pearson correlation analysis was performed to investigate the relationship between cognitive control capacity and language dominance among the bilingual participants.

4. Results

To provide contextual understanding, the demographic background of participants included age, gender, and English language proficiency scores. English proficiency was assessed using both the Sijil Pelajaran Malaysia (SPM) and Malaysian University English Test (MUET) to reinforce the distinction between balanced and Malay-dominant bilinguals based on their English language skills. Given that all participants were native speakers of Malay, Malay language proficiency was not explicitly evaluated.

Table 1 presents the demographic information of the participants. The sample consisted of 69 balanced bilinguals and 74 Malay-dominant bilinguals. To control for potential age-related variations in cognitive functions, participant ages were carefully restricted to a narrow range of 19 to 20 years.

Table 1: Demographic Characteristics of Participants at Baseline

Baseline Characteristics	**Language Groups**			
	Balanced Bilinguals (N = 69)		**Malay-dominant Bilinguals (N = 74)**	
	n	**%**	***n***	**%**
Gender				
Male	14	20.29	17	22.97
Female	55	79.71	57	77.03
Living Area				
Urban	26	37.68	27	36.49
Suburban	38	55.07	25	33.78
Rural	5	7.25	22	29.73
SPM (1119)				
1A	48	69.57	5	6.76
2A	13	18.84	13	17.57
3B	6	8.70	20	27.03
4B	1	1.45	20	27.03
5C	1	1.45	11	14.86
6C	0	0	4	5.41

7D	0	0	1	1.35
MUET				
6	0	0	0	0
5	38	55.07	0	0
4	29	42.03	39	52.70
3	2	2.90	33	44.59
2	0	0	2	2.70
1	0	0	0	0
Live outside of Malaysia				
Yes	7	10.14	2	2.70
No	62	89.86	72	97.30
Mother's academic qualification				
UPSR	0	0	1	1.35
PMR	2	2.90	2	2.70
Completed secondary education	8	11.59	20	27.03
Some post-school education/ training	11	15.94	20	27.03
Completed university degree	48	69.57	31	41.90
Father's academic qualification				
UPSR	0	0	2	2.70
PMR	1	1.45	3	4.05
Completed secondary education	6	8.70	16	21.62
Some post-school education/ training	12	17.39	17	22.97
Completed university degree	50	72.46	36	48.65

Additional demographic factors considered included gender, living area, SPM 1119 English subject result, MUET band, residence outside Malaysia, and parental academic qualifications. While gender distribution was comparable between the two groups, significant differences were observed in terms of living area. Balanced bilinguals were more likely to reside in urban areas, suggesting greater exposure to modernization and potentially contributing to their higher English proficiency compared to Malay-dominant bilinguals.

This difference in English proficiency was evident in both SPM 1119 English subject results and MUET band scores. A higher proportion of balanced bilinguals achieved higher grades in SPM 1119 and MUET, reflecting their superior English language skills. The SPM 1119 English subject results were double-marked by Majlis Peperiksaan Malaysia (MPM) and the GCE Cambridge 'O' Level examination board, ensuring rigorous assessment of English proficiency.

Parental academic qualifications were also examined to explore potential influences on bilingualism. Although there were variations within both groups, balanced bilinguals were more likely to have parents with university degrees. This suggests that parents with higher educational attainment may be more inclined to use English at home, fostering a balanced use of both Malay and English in daily life.

Research Question 1: Is there any significant difference of language dominance scores between balanced bilinguals and Malay-dominant bilinguals?

The language dominance scores are determined through the bilinguals' Bilingual Language Profile (BLP) scores; where if the scores are near to 0, the bilinguals have a balanced usage for both languages (i.e., Malay and English language) while if the scores are more positive or more negative scores reflect the respective language dominance. Hence, an independent sample T-test was done to see whether there is any significant difference of language dominance scores between balanced bilinguals and Malay-dominant bilinguals when the four factors (i.e., language history, language use, language proficiency and language attitude) are considered.

Overall, Malay-dominant bilinguals (M = 43.8, SD = 43.8) scored higher than balanced bilinguals (M = 4.96, SD = 2.77). This shows that Malay-dominant bilinguals are more dominant in the Malay language compared to balanced bilinguals who have a balanced usage of the two languages (i.e., Malay and English language). The independent samples t-test showed that the difference in score is statistically significant, $t(141) = -20.6$, p = .000, 95% CI [-43.57, -35.12]. The results suggest that the Bilingual Language Profile (BLP) can be used as a tool to measure the language dominance of bilinguals by measuring the four factors mentioned earlier.

Research Question 2: Is there any significant relationship between language dominance and cognitive control capacity among Malay bilinguals?

In answering this research question, a Pearson's correlation test is done. Assumptions on normality, homoscedasticity and linearity were assessed using descriptive statistics and scatterplots. A bivariate scatterplot between the language dominance scores and cognitive control capacity task scores demonstrated that the assumptions are met. Preliminary analyses show the relationship to be linear with both variables normally distributed, as assessed by Kalmogorov-Smirnov ($p > .05$) and it shows that there was no significant failure in the normality test. Also, based on the general rule of thumb of Cook's distance, there were no outliers in the data, as assessed by no cases with standardized residuals greater than ±3 standard deviations.

The scores obtained from the two Stroop Tasks are combined to represent the Stroop Effect. A Pearson's product-moment correlation (Table 2) was run to assess the relationship between language dominance scores and cognitive control capacity task scores between balanced and Malay-dominant bilinguals.

Table 2: Pearson correlations between language dominance scores and Stroop Effect

		Cognitive Control Capacity	**Language Dominance Scores**
Cognitive Control Capacity	Pearson Correlation	1	.345**
	Sig. (2-tailed)		.000
	N	143	143
Language Dominance Scores	Pearson Correlation	.345**	1
	Sig. (2-tailed)	.000	
	N	143	143

There was a statistically significant low negative correlation between language dominance scores and cognitive control capacity task scores (i.e., Stroop Effect), r (143)

=.345, p = .000, with language dominance scores explaining 12% (r^2 = 0.345 x0.345 = 0.119) of the variation in the bilinguals' cognitive control capacity task scores. This percentage of variance is explained by squaring the r value then multiply it by 100 to determine the percentage. It gives a measure of the amount of variation than can be explained by the model. Hence, in line with the mean scores in the descriptive analysis, the relationship between the bilinguals' language dominance scores and cognitive control capacity task scores is statistically significant. Therefore, the researcher can reject the null hypothesis and can accept the alternative hypothesis.

As previously mentioned, language dominance scores are obtained from the Bilingual Language Profile (BLP) and these scores are used to group the bilinguals into balanced bilinguals and Malay-dominant bilinguals. The data obtained from BLP showed that balanced bilinguals use Malay and English language interchangeably in their daily life while the Malay-dominant bilinguals use more Malay than English. For this research question, through language dominance, the balanced bilinguals who have good and equal fluency for both languages will be better at monitoring and inhibiting the languages they know. On the other hand, the Malay-dominant bilinguals who do not have a fair usage of both of the languages, will not have the practice at monitoring and inhibiting, or at least more practice than the balanced bilinguals. Yow and Li (2015) propose that balanced bilinguals have better cognitive control capacity than the dominant bilinguals as the co-activation of the languages requires more selective control which will enhance the bilingual language control compared to the dominant bilinguals. This is because, for the dominant bilinguals, their other language is less active due to the non-balanced language exposure, language use, language proficiency and language attitude of the other language. controlling the language dominance variable of the bilinguals is indeed crucial as the 'less practice' of monitoring and inhibiting among the dominant bilinguals would not help to enhance their cognitive control capacity.

Hence, the findings of this study are in line with previous literatures (e.g., Blumenfeld & Marian, 2013; Linck et al., 2012; Yang et al., 2018) that language dominance scores of the balanced bilinguals and Malay-dominant bilinguals have a significant relationship with their cognitive control capacity. Hence, by using the four factors in measuring the language dominance scores of the bilinguals, this study managed to support the notion that the mechanism of language dominance is related to the bilingual cognitive benefit. It can be seen through participants' BLP scores where participants who have scores near to zero in their BLP (i.e., balanced bilinguals) have smaller scores in Stroop Task which suggests that balanced bilinguals have faster reaction time to congruent and incongruent conditions compared to Malay-dominant bilinguals. This further explains that balanced bilinguals have better cognitive control capacity compared to Malay-dominant bilinguals.

5. Conclusion

This study suggests language dominance is related to bilinguals' enhanced cognitive control capacity. The findings of this study are in line with the previous literatures (e.g., Blumenfeld & Marian, 2013; Linck et al., 2012; Yang et al., 2018) that suggest a significant correlation between language dominance scores and cognitive control capacity among balanced and Malay-dominant bilinguals. By examining four factors- language history, language use, language proficiency, and language attitude- this research supports the hypothesis that language dominance mechanisms are linked to bilingual language control and can positively influence the cognitive control abilities of balanced bilinguals. In short, this study explains that balanced bilinguals have better

cognitive control capacity compared to the Malay-dominant bilinguals. Hence, it is hoped that the findings of this research could provide a basis for future research to explore different facets of bilingual benefit.

Ethics Approval and Consent to Participate

In order to answer the research questions of this study, ethics application was carried out and the study protocol was reviewed by the Ethics Committee for Research Involving Human Subjects (JKEUPM) of Universiti Putra Malaysia. Before the ethical application is approved, few modifications were made such as participant's participation, number of samplings, participants selection, age of the participants and the reliability and validity of the instruments used. Once the amendments were made, ethical approval from the JKEUPM for data collection had been obtained (Reference no. UPM/TNCPI/RMC/JKEUPM/1.4.18.2 (JKEUPM)). The ethical clearance protocol was followed, and the ethical rules and standards were maintained throughout the data collection process.

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Conflict of Interest

The authors reported no conflicts of interest for this work and declare that there is no potential conflict of interest with respect to the research, authorship, or publication of this article.

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