

# Multilinguals in a Monolingual Community: The Influence of Non-linguistic Switching Cost and Awareness of Language Environment on Intentional and Unintentional Language Switch

*Multilíngues em uma comunidade monolíngue: a influência do custo de troca não linguística e da consciência do ambiente linguístico na troca de linguística intencional e não intencional*

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## Abstract


Multilinguals who live in their native multilingual communities are constantly switching between languages, whereas those who live in monolingual communities need to constrain their code-switching. Malaysia is a multilingual country in which people mix languages on a daily basis, whereas, in Taiwan, Mandarin is predominately used and people are more cautious about code-switching. Therefore, in the current study, we investigated what factors might facilitate Malaysian-Chinese students to reduce the unintentional switching between languages to adapt to the language environment in Taiwan. Malaysian-Chinese who live in Malaysia (MIM) and Taiwan (MIT) were recruited to investigate whether and how non-linguistic code-switching and their awareness of language environment (ALE) influence their intentional and unintentional code-switching experiences. Participants' non-verbal code-switching was measured by a color/shape switching task, whereas ALE and code-switching experiences were measured by questionnaires. The multiple regression analyses of MIT's responses showed that the moderation of non-linguistic switch cost and ALE significantly predicted MIT's unintentional code-switching. Moreover, the simple slope analysis showed that MIT with high executive control have a dynamic unintentional switch in which the higher level of ALE is associated with lower unintentional switch. However, MIT with low executive control have a static unintentional switch, uninfluenced by their level of ALE. These results suggested that multilinguals' execu-

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tive control along with their awareness of the language environment help them adapt to living in a community with a predominant language.

**Keywords**

Code-Switching. Multilingual. Executive Functions. Awareness of Language Environment.

**Resumo**

Os multilíngues que vivem em comunidades que também são multilíngues estão constantemente alternando entre os idiomas, enquanto aqueles que vivem em comunidades monolíngues precisam restringir a troca de código linguístico. A Malásia é um país multilíngue onde as pessoas misturam os idiomas diariamente; já em Taiwan, o mandarim é predominantemente usado e as pessoas são mais cautelosas com a alternância entre línguas. Considerando-se essa diferença, no presente estudo, investigamos quais fatores podem auxiliar os estudantes malaios-chineses a reduzir a troca não intencional entre idiomas para se adaptar ao ambiente linguístico de Taiwan. Estudantes malaios-chineses que vivem na Malásia (MNM) e em Taiwan (MET) foram testados para compreender de que forma a troca não linguística e a consciência do ambiente linguístico (CAL) influenciam suas experiências de troca de código linguístico intencionais e não intencionais. A troca de código não verbal dos participantes foi mensurada por uma tarefa de troca de cor/forma, enquanto as experiências de CAL e de troca de código linguística foram medidas por questionários. As análises de regressão múltipla das respostas do grupo MET mostraram que tanto o custo de troca não linguística quanto a CAL foram preditores significativos da troca de código linguística não intencional. Além disso, a análise mostrou que os indivíduos do grupo MET com alto controle executivo tiveram uma troca não intencional dinâmica em que participantes com alto nível de CAL tiveram menores índices de troca não intencional. No entanto, indivíduos do grupo MET com baixo controle executivo tiveram uma troca não intencional mais estática, não influenciada pelo seu nível de CAL. Esses resultados sugeriram que o controle executivo dos multilíngues, juntamente com sua consciência do ambiente linguístico, os ajudam a se adaptar a uma comunidade que tem um idioma predominante em que a troca de código linguístico é reduzida.

**Palavras-chave**

Troca de código linguístico. Multilíngue. Funções executivas. Consciência do Ambiente Linguístico.

**Introduction**

In the 21<sup>st</sup> century, learning more than one language is a common trend for people who are living in this globalized world because it tends to lead them to more opportunities in their professions, as they can communicate with different people with different ethnical and language backgrounds, instead of communicating with people with similar backgrounds. Additionally, many studies have indicated that bilinguals and multilinguals have better executive functions than monolinguals, particularly in inhibiting irrelevant information (e.g. BIALYSTOK & MARTIN, 2004; BIALYSTOK *et al.*, 2005; YOSHIDA *et al.*, 1990). For instance, BIALYSTOK and MAJUMDER (1998) examined different bilinguals (French-English bilinguals, Bengali-English bilinguals) and English-speaking monolinguals on the nonverbal problem-solving abilities, which were measured by Block Design Task and Water Level Task. Results indicated that proficient French-English bilinguals showed better performance on the non-linguistic tasks than both the less proficient Bengali-French bilinguals and the monolinguals, which demonstrated higher levels of bilingualism associated with higher levels of control of executive functions. Moreover, in POARCH and VAN HELL (2012), trilinguals and bilinguals

showed lower Simon effects than monolinguals. Additionally, they experienced more advantages from the orienting cue and less interference from incongruent flankers than second-language learners in the Attentional Network Task.

One of the possible reasons behind bilinguals' cognitive advantage is that bilinguals' lexical access is non-selective in nature. Therefore, when bilinguals use one language, the other language is still activated (e.g. HOSHINO & KROLL, 2008; MARIAN & SPIVEY, 2003; MISHRA & SINGH, 2013; STARREVELD *et al.*, 2014). Because all languages are activated in the early stage of lexical processing, as a consequence, there must be a cognitive competition process to decide which language to use given the circumstances. Choosing the appropriate language is not just about activating a specific language but also about inhibiting the language that is not in use. Inhibition is one of the three major components of executive control (MIYAKE *et al.*, 2000) and according to Green's Inhibitory Control model (GREEN, 1986), bilinguals and multilinguals may actively inhibit the activation of one language when using the other. This inhibition is especially stronger when the subordinate language is in use, because more effort is needed to inhibit the dominant language. However, it was also reported that bilinguals may have learned to suppress the not-in-use language through local reactive inhibition (LOGAN, 1994).

COLZATO *et al.* (2008) has compared bilinguals and monolinguals' performances on Signal Performance (experiment 1) and Attentional Blink (experiment 3) tasks to evaluate the active and reactive inhibition mechanisms. The first task is more related to the active inhibition while the second one is more related to reactive inhibition. They have found no group differences on Signal Performance, but bilinguals showed larger attentional blink at short lag, supporting reactive inhibition mechanism.

Since the experiences of selective activation of one language and inhibition of the other could be the main reason for bilinguals' cognitive advantage, the bilinguals that most often switch between languages should have the most cognitive benefits (e.g., better executive functions). Code-switching is a language phenomenon in which bilinguals or multilinguals alternate and mix two languages (ZENTELLA, 1997). Generally, code-switching is an intentional behavior in which bilinguals purposely switch their languages depending on various reasons such as topic or the people they communicate with (FESTMAN *et al.*, 2010). It has been found that bilinguals' linguistic code-switching experiences are similar to the non-linguistic task switching abilities (PRIOR & GOLLAN, 2011). In their study, Spanish-English bilinguals who are more often to code-switch than Man-

darin-English bilinguals showed lower switching costs in the non-linguistic color/shape switching task, indicating better executive functions.

In addition to the intentional code-switching, another kind of code-switching refers to bilinguals switching languages without conscious intention, namely the unintentional code-switching (POULISSE & BONGAERTS, 1994). In contrast with intentional code-switching, unintentional code-switching can be seen as an indication of which bilinguals are incapable of staying in single language status when needed. Therefore, past evidence assumed that people who tended to code-switch unintentionally could also have poor executive functions abilities. FESTMAN *et al.* (2010) used a bilingual picture naming task to categorize bilinguals into those who performed better in naming the pictures in the designated language and those who are not. She then classified those who often named the pictures in the wrong languages as (unintentional) switchers. The participants then participated in four executive functions tasks: Tower of Hanoi, Go/noGo Paradigm, Divided Attention task and Ruff Figural Fluency Test (RFFT). Results found that the non-switcher group demonstrated that they had a better performance on the Tower of Hanoi and Ruff Figural Fluency Test, faster reaction in Go/noGo Paradigm and Divided Attention task and significantly fewer errors in the Tower of Hanoi and Divided Attention task, which compared to the switchers, showing that non-switches had better executive functions such as the ability of inhibition, self-monitoring and problem solving.

In addition to behavioral measurements of intentional code-switching, SOVERI *et al.* (2011) used the Bilingual Switching Questionnaire (BSWQ; RODRIGUEZ-FORNELLS *et al.*, 2012) to measure the participants' levels of intentional code-switching and unintentional code-switching. Measures from the BSWQ were used in the multiple-regression analyses. Results have shown that bilinguals who often unintentionally code-switch performed worse in the Flanker task, indicating that the usage of unintentional code-switching leads to poorer executive functions. However, people who were high in intentional code-switching performed better in the Flanker task and the Simon task indicating that switching languages consciously led to better executive functions. The aforementioned studies examined the effect of the level of code-switching on executive functions. However, no studies have been done to examine whether and how bilinguals' or multilinguals' executive functions contribute to their daily language code-switching experiences and it is possible that the causal relationship between language code-switching and executive functions is not only one-way, but two-way. In other words, not only code-switching experience could enhance ex-

ecutive functions, but executive functions could also alter language code-switching behaviors. Hence, the primary purpose of the present study was to investigate to which extent Chinese-English-Malay trilinguals' intentional and unintentional code-switching experiences could be predicted by their executive functions.

Mandarin-English-Malay trilinguals were selected as the participants due to their rich multi-language experiences. They mix Mandarin, English, and Malay in their daily communication and can switch to each language spontaneously. For example, the sentence "kawan, you want to eat mi-goreng ma?" (Friend, do you want to eat fried noodles?) consists of three languages: Malay ("kawan" and "mi-goreng"), English ("you want to eat") and Mandarin ("ma"). They use this kind of sentences to communicate with each other who are in the same language background on a daily basis. We predicted that trilinguals with better executive functions would demonstrate a higher level of intentional code-switching and lower level of unintentional code-switching. On the contrary, trilinguals with poor executive functions would show lower levels of intentional code-switching and higher levels of unintentional code-switching. In this study, a non-linguistic color/shape switching task was used to measure participants' executive functions and the higher the non-linguistic switching cost the lower the executive functions (PRIOR & GOLLAN, 2011).

In addition to the general cognitive factors, some pragmatic factors may also influence bilinguals' or multilinguals' language-switching behaviors (e.g., ALE). In this study, ALE refers to a person's awareness of the linguistic diversity in their environment. As mentioned before, Mandarin-English-Malay trilinguals switch between three languages spontaneously, the language switching happens naturally without their conscious awareness; however, they cannot speak in the same pattern once they move to a place where most people mainly use only one language, for example, in Taiwan, Mandarin is predominately used and people are quite conscious about their code-switching. According to the data from the Minister of Education in Malaysia, more than 70000 Malaysian students study in foreign countries annually thus Taiwan is ranked as the third most popular country (The edge markets, 2020, October 12). Moreover, according to the Minister of Education in Taiwan, more than 90000 Malaysian students have chosen to study abroad in Taiwan since 2015 (The new southbound talent development program, n.d.). This large number of Malaysian students in Taiwan provides us a unique opportunity to study how trilinguals adjust their language usage from high to low linguistic diverse and whether their ALE would influence their code-switching behaviors or even whether ALE would interact with executive

functions and influence the code-switching behaviors.

Therefore, the second purpose of this study was to investigate whether the experiences of studying abroad in a predominantly monolingual society (i.e. Taiwan) would lead Mandarin-English-Malay trilinguals' to adjust their ALE and the individual differences of ALE would associate with their intentional and unintentional code-switch. In the current study, Malaysian trilinguals who live in Malaysia (MIM) and those who live in Taiwan (MIT) were recruited and their ALE were measured. We hypothesized that MIT would have higher ALE than MIM and the MIT who are more aware of the language environment they live in the more likely they would avoid unintentional code-switch and enhance intentional code-switch to the local dominant language, Mandarin.

## **1 Research Methods**

### **1.1 Participants**

MITs (23 females with a mean age of 21.98 years) and MIMs (26 females with a mean age of 21.93 years) were recruited in this study. MITs have lived in Taiwan for an average of 35 months, and MIM lives in Malaysia currently. All of them are Mandarin-English-Malay trilinguals and their language history and proficiency for each language were reported according to the self-reported Language History Questionnaire (LHQ 3; LI *et al.*, 2019). This study has been approved by the research ethics committee (REC) of Department of Chung Yuan Christian University (REC number: 110031501).

### **1.2 Materials**

#### **1.2.1 Language History Questionnaire (LHQ 3)**

Language History Questionnaire (LHQ 3) is a self-reported tool used to assess the participants' language background and their proficiency, immersion and dominance of each three languages, including Chinese, English, and Malay. This questionnaire was invented by LI *et al.* (2019), which is based on the Language History Questionnaire (LHQ 2.0; LI *et al.*, 2014) and then added the automatic scoring system to calculate the language proficiency, language dominance and language immersion levels.

### 1.2.2 The Bilinguals Switching Questionnaire (BSWQ)

The original BSWQ is a survey firstly developed by RODRIGUEZ-FORNELLS *et al.* (2012) to study individuals' experiences on language-switching. The questionnaire consists of four parts, namely L1 switching tendencies (L1-switch), L2 switching tendencies (L2-switch), Contextual switch and unintended switch. This questionnaire is slightly modified and translated into Mandarin in order to fit Mandarin-English-Malay trilinguals' language using experiences. The revised questionnaire consists of five parts:

- (1) L1 switching tendencies (the tendencies to switch from English or Malay to Mandarin)
- (2) L2 switching tendencies (the tendencies to switch from Mandarin or Malay to English)
- (3) L3 switching tendencies (the tendencies to switch from Mandarin or English to Malay)
- (4) Contextual switch
- (5) unintentional switch.

Participants responded to each item on a 5-point scale ranging from never (1) to always (5). Three scores were generated for each participant, namely intentional switch, contextual switch, and unintentional switch and intentional switch was created by adding up the scores on the first three parts (L1, L2, and L3 switching tendencies). The internal consistency analyses showed Cronbach's alpha value is .76 for intentional switch, .79 for contextual switch, and .62 for unintentional switch.

### 1.2.3 Language-environment awareness questionnaire (LEAQ)

LEAQ was developed for two purposes. One was to examine to what extent MIT, in comparison with MIM, would be more aware of their language environment and adjust their language usage habits accordingly. The other purpose was to measure and test whether and how MIT and MIM's individual differences on ALE would moderate the relationship between executive functions and unintentional code-switching experiences respectively. The second author of this study is a MIT student, so initially she generated 8 questions related to her study abroad experience and then consulted with 5 other MIT peers who assessed the

questions based on the likelihood that these questions reflect MIT students' experiences with language use. Based on their feedback, the authors reduced the number of questions from 8 to 4 and revised the wording.

The questionnaire includes four questions, and the participants respond on a 5-point scale varying from never (1) to always (5). Item 4 is reverse coded and each participants' score is the sum of scores of all four items. The internal consistency analyses showed that Cronbach's alpha value is .61 for MIT and .73 for MIM. According to NUNNALLY and BERNSTEIN (1994) and TABER (2018),  $\alpha$  above .6 is considered moderate, sufficient, and acceptable. Four items in LEAQ are listed below.

- (1) When I communicate with others face-to-face, I will control my language-switching in the place where I live now.
- (2) When I text someone in the place where I live now, I will only text in Mandarin instead of mixing with English and Malay.
- (3) When I call others in the place where I live now, I will only talk in Mandarin instead of mixing with English and Malay.
- (4) I use English and Malay more than 5 times a day.

#### **1.2.4 Non-linguistic color/shape switching task**

A non-linguistic color/shape switching task was created based on PRIOR and GOLLAN (2011). In this task, participants made color and shape judgments on stimuli presented on a monitor, using keyboard press to indicate their selection. The cue for the color task was a color gradient. As for the shape task, the cue was a row of small black shapes. Half of the participants performed the color task either using the right hand or left hand and the other half performed the shape task either using the left hand and the right hand. Participants completed three parts of the task, comprising a sandwich design. Firstly, two single-task blocks were presented, color task was presented first and shape task was presented afterwards, each including 8 practice trials and 36 experimental trials. Secondly, 16 mixed-task practice trials, followed by 3 mixed-task blocks of 48 trials each. In each mixed block half of the trials are switch trials and half are non-switch trials, of both the color and shape tasks, randomly ordered with a maximum of 4 consecutive trials of the same type. Finally, in the third part of the experiment, participants again performed two single-task blocks, present in the opposite order that was used in the first part. Correct response times (RTs) and accuracy were analyzed to be the individual's cognitive abilities as switch costs and mixing costs.



This task procedure was programmed with E-Prime 2.0.

## 2 Results

### 2.1 Language History Questionnaire (LHQ 3)

We calculated the participants' scores on proficiency, immersion, and dominance according to the formula provided by LI *et al.* (2019). The calculated scores are ranged from zero to one and the higher the score, the higher the proficiency, immersion, or dominance level of a language. The average scores and *SDs* of intentional switch, unintentional switch and contextual switch are listed in table 1. Three two-way repeated ANOVAs with Group (MIT and MIM) and Language (Chinese, English and Malay) as independent variables were applied to examine the participants' proficiencies, immersion and dominance. For proficiency, the results showed that there is no group difference between MIT and MIM and the main effect of Language was significant ( $F(2, 156) = 145.11, p < .01$ ). Post-hoc analysis with Bonferroni adjustment showed that both groups have higher proficiency in Chinese, followed by English and then Malay. Similar results were found in immersion dominance, the main effect of Language was significant (immersion:  $F(2, 156) = 95.41, p < .01$ ; dominance:  $F(2, 156) = 239.46, p < .01$ ) and post-hoc analysis showed that both groups have higher immersion and dominance in Chinese, followed by English and then Malay.

**Table 1 - Means and standard deviations of participants' characteristics in LHQ**

Group	MIT		MIM	
Sample size	40		40	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age	21.98	1.29	21.93	1.288
Proficiency				
Chinese	.850	.116	.837	.133
English	.601	.150	.654	.128
Malay	.539	.134	.582	.123
Immersion				
Chinese	.602	.036	.613	.028

English	.533	.076	.557	.053
Malay	.525	.072	.537	.061
Dominancy				
Chinese	.575	.099	.551	.098
English	.341	.102	.415	.111
Malay	.279	.080	.308	.076

Source: The authors.

## 2.2 The Bilinguals Switching Questionnaire (BSWQ)

The average scores and *SDs* of intentional switch, unintentional switch and contextual switch are listed in Table 2. Three one-way ANOVAs were applied to test the groups' differences on intentional, unintentional and contextual switch. Results indicate that the intentional switch and unintentional switch do not show significant difference between MIT and MIM,  $F(1,78) = .211, p = .647$ ;  $F(1,78) = .186, p = .668$ . However, in contextual switch subscales, there is a significant difference between two groups of Malaysian,  $F(1,78) = 5.796, p = .018$ , indicating that MIM has the more frequent switches that are usually triggered by a particular scenario or environment. It is expected that MIM needs to communicate with other ethnic groups such as Malays or Indians daily.

**Table 2 - Means and standard deviations in The Bilingual Switching Questionnaire subscales**

Group	MIT		MIM	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Intentional Switch	30.25	5.242	29.70	5.459
Contextual Switch	7.93*	2.712	10.33*	2.485
Unintentional Switch	8.80	2.151	9.02	2.506

\* $p < .05$ .

Source: The authors.

### 2.3 Language-environment awareness questionnaire (LEAQ)

Each participant's scores of LEAQ were calculated as the sum of scores of all four items. A one-way ANOVA was applied to examine the differences between MIT ( $M = 13.92, SD = 3.25$ ) and MIM ( $M = 9.33, SD = 2.97$ ). The result shows that there is a significant difference between MIT and MIM,  $F(1, 78) = 43.57, p < .001$ , which indicates that MIT has higher awareness about their language usage in their daily life and they tend to control not to switch their languages frequently. Therefore, even though both of them have learned three languages since they were young, the environment they currently live in would cause them to adjust to different language-switch habits.

### 2.4 Non-linguistic color/shape switching task

In non-linguistic color/shape switching task, reaction time in single, repeat and switch task between MIT and MIM showed no significantly difference,  $F(1, 78) = .008, p = .927$ ;  $F(1, 78) = .026, p = .873$ ;  $F(1, 78) = .095, p = .758$ . Using one-way ANOVA analysis, both of them indicated that there was no difference in switch costs and mixing costs,  $F(1, 78) = .110, p = .741$ ;  $F(1, 78) = .028, p = .868$ . The result implied that the executive functions of MIT are the same as MIM. Additionally, accuracies in switch costs and mixing costs between MIT and MIM were also analyzed using one-way ANOVA, the result showed that there was no significant difference in MIT and MIM,  $F(1, 78) = .482, p = .49$ .

**Table 3 - Means reaction time, standard deviations and costs in the non-linguistic color/shape switching task**

Group	MIT		MIM	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Trial Type				
Single	517.308	79.644	519.730	146.452
Repeat	723.155	134.831	731.527	301.829
Switch	827.725	166.306	843.718	282.211
Switch Costs	104.570	91.290	112.191	113.381
Mixing Costs	205.847	122.874	211.797	189.504

Source: The authors.

## 2.5 Regression analyses

The regression analyses consist of two parts. Firstly, to test whether non-linguistic switching contributed to participants' intentional and unintentional language switch, we conducted two simple linear regression analyses in all participants. The independent variable is the non-linguistic switching cost and the dependent variables are the intentional switch and unintentional switch respectively. Both models did not reach significant (intentional:  $F(1, 79) = .90, p = .35$ ; unintentional:  $F(1, 79) = 2.15, p = .15$ ); however, participants with higher non-linguistic switching cost tended to show more unintentional switch.

Secondly, because MIT and MIM performed significantly differently on LEAQ as predicted, MIM and MIT are analyzed separately in the following analyses. Two multiple regression analyses, one for MIT and the other one for MIM, were conducted with intentional switch as the dependent variable; and Z scores of switch costs, ALE and the interaction term, switch costs  $\times$  ALE as independent variables. The results showed that both models did not reach significant (MIT:  $F(3, 39) = .18, p = .91$ ; MIM:  $F(3, 39) = .56, p = .65$ ), suggesting that participants' intentional switch cannot be predicted by none of ALE, switch costs and their interaction.

Moreover, the same data analysis procedures were also applied to unintentional switch. The results of regression analysis for MIT showed that the three predictors explained 24% of the variance ( $F(3, 39) = 3.8, p = .018$ ) and ALE ( $B = -.91, \beta = -.422, t = -2.83, p = .008$ ) as well as switch  $\times$  ALE ( $B = .82, \beta = .36, t = 2.38, p = .023$ ) were significant predictors. These results indicate that MIT with higher ALE were less likely to generate unintentional code-switching. More importantly, the interaction of ALE and non-linguistic switching cost significantly associated with unintentional switch. To identify the effect of switch costs on unintentional switch at different levels of ALE, we conducted a moderation analysis using SPSS Process based on HAYES (2018) with unintentional switch as the dependent variable, switch cost as the independent variable and ALE total score as the moderator. The results for the whole regression model and each predictor are the same as the aforementioned multiple regression analysis. The following conditional effects of switch costs on unintentional switch at high, low (1 SD below and above the mean) and medium ALE are demonstrated in Figure 1. These results suggest that for those participants with low ALE and low switch cost tended to have the most unintentional switch, but on the other hand, participants with high ALE and low switch cost tended to avoid unintentional switch. Additionally, the unintentional switch experiences of participants with high switch cost are not influenced

by their ALE. Using the same statistical procedures, regression analyses for MIM showed that the three predictors explained 13% of the variance ( $F(3, 39) = 1.84, p = 1.57$ ).

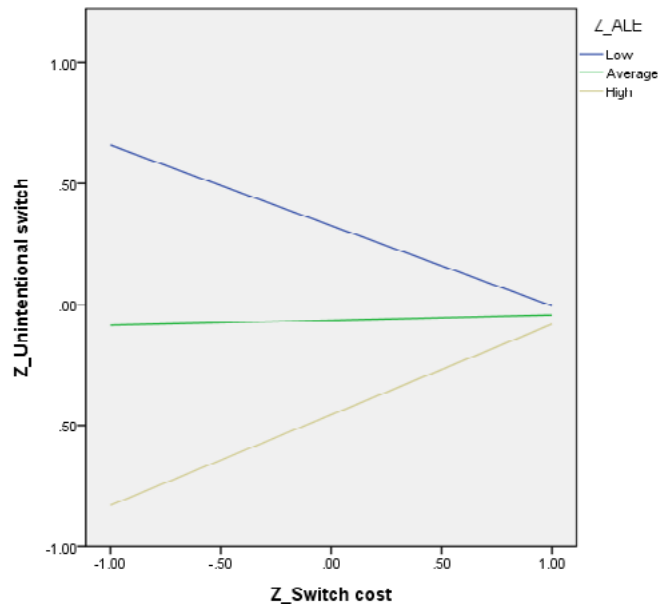
**Table 4 - Multiple linear regression analyses: Unintentional switch predicted by switch costs, ALE and their interaction in MIT and MIM**

Unintentional switch				
	MIT		MIM	
	$R^2$	$\beta$	$R^2$	$\beta$
Model	.241*		.133	
Switch costs		.023		.220
ALE		-.422**		.009
Switch costs $\times$ ALE		.360*		.287

\* $p < .05$ . \*\* $p < .01$ .

Source: The authors.

**Figure 1 - Simple slopes for the moderation of switch costs on unintentional switch by ALE at -1 SD (low) and +1 SD (high) of the centered means**



Source: The authors.

### 3 Discussion

The purpose of this study was twofold. First, we investigated the extent of Mandarin-English-Malay trilinguals' executive functions measured by color/shape switch cost, can predict their intentional and unintentional switch between languages. We hypothesized that participants with better executive functions would show a higher level of intentional code-switching and lower level of unintentional code-switching and with poor executive functions would show a lower level of intentional code-switching and higher level of unintentional code-switching. Secondly, we examined whether Malaysian students who study in Taiwan would be more aware of the language environment they are surrounded by than those who study in Malaysia. Moreover, whether their awareness of the language environment would directly influence or interact with executive functions to influence participants' language switch experiences.

The simple regression analyses showed that color/shape switching cost are not predictors towards participants' intentional and unintentional language switch experiences. The preliminary assessment of these results is that executive functions and language switch do not form a two-way relationship. Hence, the long-term and rich language switch may shape multilinguals' general executive functions as previous studies have shown, but that does not indicate a causal relationship of executive function influencing language switch experiences. However, after comparing our participants' demographical background with the ones from previous studies, we suspected other possible explanations. The participants' average age in SOVERI *et al.* (2011) is 53 compared to this study's average age of which is 22. Therefore, participants in this study

may have better overall executive functions than those in Soveri's study due to age. It has been proposed that when multilinguals become senior the ability to select the appropriate language and switch correctly would be declined and unintended mixture of languages would increase (ARDILA & RAMOS, 2008). Therefore, it is possible that even though executive functions may influence multilinguals' language switch behaviors, this influence would be more noticeable in the senior participants than younger ones. To test whether our suspicion would be correct, more sensitive measures such as eye-movements on executive functions should be applied in future studies (HEUER & HALLOWELL, 2015; HEUER & PINKE, 2017).

Another explanation is related with the second purpose of this study which was to clarify the relationship of ALE-executive functions-language switch. The

participants of the current study consist of Malaysian university students who are studying abroad in Taiwan as well as those who study in Malaysia. In general, the former are more sensitive at choosing the appropriate language when interacting with others, which reflects MIT's adaption to the monolingual environment. Moreover, the multiple regression analyses and following moderation analysis showed that MIT's ALE is not only directly associated with unintentional switch, but also moderated with the relationship between color/shape switch cost and unintentional switch. MIT with high color/shape switch cost (i.e. low executive functions) tended to have more fixed unintentional switch regardless of the level of ALE. That is to say even for those MIT who are quite aware of the language usage in the environment, they may be incapable of reducing the intrusion of non-target languages, most of the time English or Malay, in their conversations. On the other hand, for MIT with low high color/shape switch cost (i.e. low executive functions), their unintentional switch behaviors are more influenced by pragmatic factors (e.g. ALE). In other words, even though they can reduce the involvement of English or Malay in their conversations, whether they actually reduce the unintentional switch or not depends on their awareness toward the language environment. In contrast with MIT, MIM's ALE neither directly influences the language switch nor interacts with color/shape switch cost to influence language switch. This result can be explained by the fact that MIM don't have the need to constrain language switch as most of the people they interact with have the same language background in which language mixture or switch is extremely common. The above results suggest that language switch is a complex phenomenon that can be attributed to many different factors. Execution functions are more associated with multilinguals' capacities to not indulge in unintentional language switch, despite the fact that cross-language activations are constantly happening. However, whether they would actually avoid unintentional switch depends on the level of their awareness towards the language environment and the level of acceptance of language mixture and switch in a language environment.

There are several limitations regarding this research. Although the ethnic of trilingual participants recruited are Chinese, they come from very diverse language education backgrounds. In Malaysia, there are multiple primary and secondary education systems such as National Secondary Schools, in which Malay is the main medium of instruction; Chinese independent schools, in which the medium of instruction is Mandarin and International Schools, in which English is the medium of instruction. As a consequence, even though they are all fluent in Mandarin, English and Malay according to the self-report measures, the relative

proficiencies are varied across participants. Not analyzing participants' heterogeneous language background in detail may limit our ability to investigate why there is no association between intentional code-switch and any of the predictors. The reason is that participants may need strong intentions to switch from more proficient to more less proficient languages, but which one is more proficient and which one is less are different one from another. Secondly, executive functions are a collection term consisting of many cognitive abilities such as attentional control, cognitive flexibility and working memory, and the non-linguistic color/shape switching task used in this study only related with a portion of these cognitive abilities. For instance, according to MIYAKE *et al.* (2000), executive functions include updating, inhibition and shifting, but color/shape switching may be more related with inhibition and shifting, but not updating. Moreover, ANS, the well-known attentional control task measures individuals' alerting, orientation and conflict resolution. Nonetheless, color/shape switching is only related to conflict resolution. Therefore, not including a variety of executive functions tasks limit our ability to have a more complete picture about the relationship between language switch and different aspects of executive functions.

In conclusion, this is a preliminary study to examine to what extent multilinguals' executive functions and the awareness of language environment can predict their intentional and unintentional language switch. We found that when multilinguals live in a predominantly monolingual society, their awareness of the language environment can moderate with executive functions to modify unintentional language switch. This interaction is new and has not been found in the previous study and more future studies are needed to explore this field.

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