

L2 PRONUNCIATION PROFICIENCY, LANGUAGE USE AND AGE OF ACQUISITION AS PREDICTORS OF EXECUTIVE CONTROL IN BILINGUALS

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ABSTRACT

The primary objective of this study was to investigate the extent to which second language (L2) pronunciation proficiency, language use, and age of L2 acquisition (AoA) are associated with variation in enhanced executive control in bilinguals. The secondary objective was to examine whether bilinguals' executive control, as reflected in the incongruent response time for the Flanker task, differed from a group of monolinguals.

A multiple regression revealed that although neither pronunciation proficiency in the L2 of English nor AoA were significant in predicting enhanced executive control, L2 use was highly significant. However, there was no significant difference between the incongruent response times of the bilinguals versus the monolinguals.

The findings suggest that different forms of bilingualism, as a non-categorical experience, impact executive control differently, and that not all forms of bilingualism are equally afforded an advantage in executive control over monolingualism.

Keywords: L2 pronunciation proficiency, language use, AoA, bilingualism, monolingualism, executive control

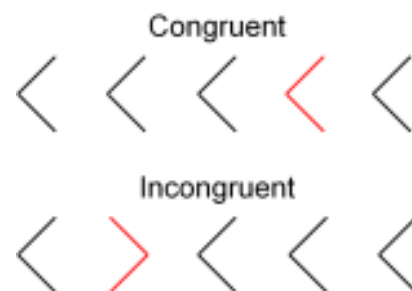
1. INTRODUCTION

The idea that “bilingualism cannot be treated [...] as a unitary phenomenon” (103) is relatively uncontroversial [1]. An extension of this idea is that the effects which bilingualism has on other domains might not surface as a unitary phenomenon. One such domain is executive control [1]. Briefly, executive control processes are hypothesised to supervise “the selection, initiation, execution, and termination” of multiple task performance [2].

There is a growing body of prolific research which indicates that bilingualism as such affords advantages over monolingualism in executive control processes [3, 4]. The explanation for this bilingual effect is that bilinguals, in contrast to monolinguals, need to constantly manage attention to their two languages, and that the executive control network is recruited for this purpose [5].

However, a small body of research suggests that individuals who are proficient in more than one language, i.e. bilinguals, do not benefit uniformly from enhanced executive control. Such studies often implement the Flanker task, a non-linguistic task which is claimed to require cognitive processing recruited in the executive control network [6]. In this task, participants are required to press the right button on a joy-stick if the red arrow (see Figure 1) is pointing to the right and the left button if the red arrow is pointing to the left. Red arrows are presented either in congruent trials with flanking black arrows pointing in the same direction as the red arrow, or incongruent trials, with flanking black arrows pointing in the opposite direction. Generally, a longer response time (RT) is evidenced for incongruent trials than congruent trials as conflict resolution is required. However, bilingualism has been shown to moderate Flanker task performance (i.e. bilinguals tend to be faster and make fewer errors), presumably because bilinguals are more adept at task management involving inhibition, activation and selection as this is also required of them in their language control.

Figure 1: An example of congruent and incongruent trials in the Flanker task.



Through means of the Flanker task, it has been shown that only unimodal bilinguals (those who use two or more languages within the same modality, such as two spoken languages) exhibit enhanced executive control over bimodal bilinguals (those who use two or more languages in different modalities, such as one spoken and one signed language) and monolinguals [7]. To explain their findings of the unimodal bilingual advantage, Emmorey et al. [7] proposed that

“[u]nimodal bilinguals are constantly faced with more challenging production demands because their languages utilize the same articulation system” (1205), and that it is this difference in production mode which drives the benefits in executive control in unimodal bilinguals versus bimodal bilinguals. From a phonetic perspective, this is interesting because it could mean that articulatory control in unimodal bilinguals (as opposed to, e.g. syntactic knowledge) is associated with executive control.

Similarly, it has been demonstrated that late unimodal bilinguals (L2 learned at approx. 10 years of age) performed more like monolinguals on the Flanker task, whilst early unimodal bilinguals evidenced benefits [8]. Building on these findings, Costa et al. [9] used an adapted version of the Flanker task in order to assess executive control in unimodal bilinguals and monolinguals and found that the bilinguals who had *used* both of their languages from birth onwards were faster than monolinguals “irrespective of whether the trial was congruent or incongruent” (77). They suggested that the mechanisms involved in resolving the conflict which arises when competing stimuli are presented are more efficient in bilinguals due to the constant management of their two language systems. Such ground-breaking findings gave rise to the current research, the primary objective of which was to determine the extent to which L2 pronunciation proficiency, age of L2 acquisition, and L2 daily use impacted a group of Spanish first language (L1) – English L2 unimodal bilinguals’ performance on the Flanker task.

2. METHODOLOGY

The study comprised two data collection phases. The first phase was the collection of data from the speakers, who were recorded in either Madrid, Spain or London, United Kingdom. The second phase was the L2 pronunciation proficiency assessment of those speakers, which was conducted in London, United Kingdom. This research was part of a larger study, and only portions relevant to the current objectives are reported here.

2.1. Experimental procedure

In the first data collection phase, the same procedure was followed in both Madrid and London, where the recordings were conducted in a sound attenuated room at the Laboratorio de Fonética at the Centro de Ciencias Humanas y Sociales or the Speech, Cognition and Society Laboratory (SCS Lab) at Queen Mary, University of London.

After the participants had filled in an adapted version of the MPI Language Background Questionnaire, the participants read Aesop’s fable

“The North Wind and the Sun”. This standard phonetic text was chosen to ensure that similar vocabulary and syntactic complexity were produced by all participants so that subsequent listener assessments would be based on solely pronunciation of the bilinguals in their L2. A focus on pronunciation proficiency was considered crucial given Emmorey et al.’s [7] interpretation of their findings that articulation demands are the source of executive control advantages in bilinguals (as bimodal bilinguals did not evidence an advantage in their study). Accordingly, one might expect unimodal bilinguals with a *high* L2 phonetic proficiency (i.e. a native-like pronunciation in their L2, and a native pronunciation in their L1) to evidence greater benefits in the Flanker task, as a more target-like pronunciation could purportedly require “more challenging production demands” (1205) than a less target-like pronunciation, although this might depend on the conditions in which one acquired the target-like pronunciation. Alternatively, it could be that unimodal bilinguals with a *low* L2 phonetic proficiency (i.e. a less than native-like pronunciation in their L2, but a native pronunciation in their L1) would evidence greater benefits in executive control, as measured by the Flanker task, as more attention could be required for pronunciation in this case. It could also be that regardless of pronunciation proficiency in the L2, a benefit in unimodal bilinguals would surface across the board, simply as a function of the single production mode.

The Flanker task (see Figure 1) was the final step in the experimental procedure. Participants were instructed to indicate the direction the red arrow was pointing as quickly and accurately as possible. There were three types of blocked trials of which only the final conflict block, which is the actual Flanker task, was analysed in order to determine the RTs of the incongruent trials. This block consisted of an equal number of congruent trials and incongruent trials. In the conflict resolution condition, participants had to focus only on the direction of the target arrow whilst ignoring the flanking distractors. The Flanker task was administered using a laptop computer with a gamer joy-stick. Participants were instructed to put their left index finger on the left button of the joy-stick and their right index finger on the right button. Each stimulus was presented for 2,000ms during which the participant’s response was made. Both RT and accuracy were measured for all blocks but only incongruent trials are reported for reasons of brevity.

2.2. Speakers

Twenty-eight individuals considered to be bilinguals were compared with 10 individuals considered to be

monolinguals (see Table 1). As revealed through the adapted version of the MPI language background questionnaire, all bilinguals listed Spanish as their native language, had learned Spanish from birth onwards, and learned English as their L2 in childhood. Some were proficient in other languages, but all listed English as their second most dominant language after Spanish. As such, English was also reported to have the second highest proficiency rating after Spanish: 3.5 or higher on the scale of 1(lowest) to 5(highest). Additionally, Spanish was reported to be the overwhelmingly most used language before they entered school, although thereafter L1 and L2 use varied. Overall, therefore, the bilinguals in this study were sequential bilinguals with a relatively high proficiency in English, varying in frequency of L2 use and AoA. In contrast, the 10 monolingual English native speakers always self-assessed their proficiency in other languages to be equal to or beneath 3.5; all of the monolinguals reported to presently speak English 95% of the time, and similarly, before school entry to have spoken English at least 95% of the time. Due to foreign language education, some of the monolinguals' L2 use increased during school, but it approximated 90% on average throughout their lives. Therefore, in general, on the continuum of monolingualism to bilingualism, we consider them to be functional monolinguals.

Table 1: Language background information of bilinguals. Standard deviations of age at recording (AaR), age of English acquisition (AoA) and L2 use are in brackets behind means.

AaR (yrs)	AoA (yrs)	L2 use (%)
25.8 (5.5)	6.1 (2.3)	37.0 (18.5)

2.3. Speech Materials

For the second data collection phase, a recording was created from “The North Wind and the Sun” including sections of two to four words from each speaker, which were semi-balanced for syllable count, taking intonational breaks into consideration. This edited version resulted in a recording of 9:20min. The listeners, as described below, heard each sentence twice in succession which was considered to be less tiring and to evoke higher attentional levels than repeating the entire story once, and then again.

2.4. Listeners

Seven native speakers of British English (3 female; 4 male) with a mean age of 27.7 years judged the speech samples. They were recruited from the

students and employees at Queen Mary, University of London and all of them identified as being native monolingual speakers of English and as being monolinguals in an abridged version of the MPI language background questionnaire. Each sample of two to four words was followed by a break of seven seconds during which the listeners made their judgements: (1) speaker's authenticity on a 2-point scale, i.e. native versus non-native; (2) level of confidence for previous judgement on a 3-point scale, i.e. high, mid, low; (3) perceived foreign accent on a 10-point scale with 1= native and 10=non-native. This resulted in a 0-14 scale (0=definitely native, 14=definitely non-native) (see Table 2).

Table 2: Averaged results from English pronunciation proficiency assessment for monolinguals and bilinguals. Standard deviations are in brackets.

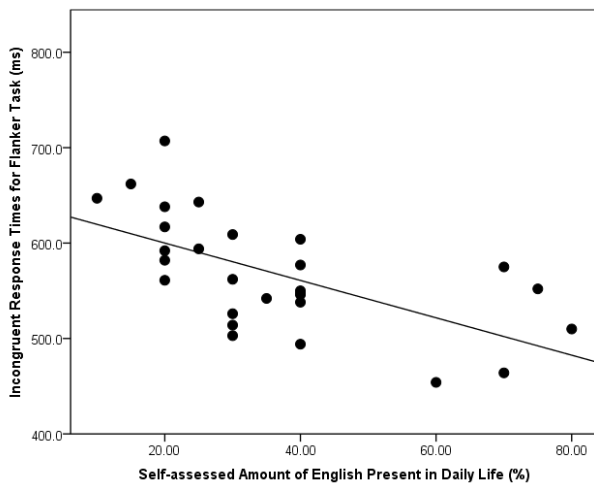
Monolinguals	Bilinguals
2.0 (2.1)	9.0 (3.0)

3. RESULTS

In order to investigate the primary objective, a linear regression was conducted with incongruent trial RT as the dependent variable. The order of the entered predictor variables was: (1) L2 phonetic proficiency; (2) age of L2 acquisition; and (3) amount of current L2 use in daily life. Only the third model was significant ($F(3,24)=7.195, p<.001$) with a total adjusted R^2 of .408, indicating that self-assessed amount of daily L2 use was responsible for over 40% of the variation of executive control in the bilinguals. In this model, amount of L2 use was the only significant predictor variable with a standardized beta value of -.640; those unimodal bilinguals who used more English in their daily lives were faster on incongruent trials of the Flanker task than those who used less English in their daily lives (see Figure 2), i.e. enhanced executive control was associated with a high amount of daily L2 use.

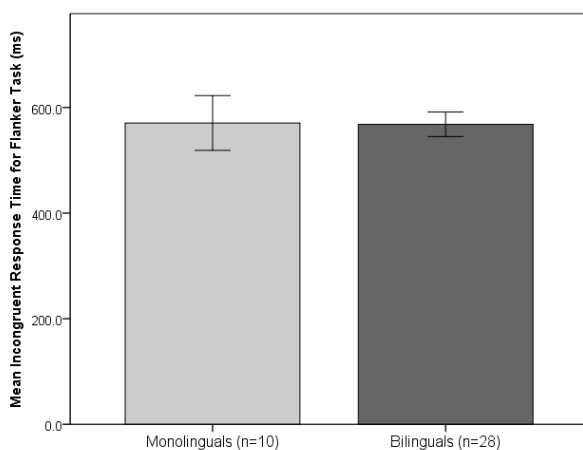
To examine the secondary objective of this study, an independent samples t-test was conducted to compare the monolinguals with the bilinguals on the same dependent variable (incongruent RT), as in both groups the Shapiro-Wilk test indicated that the data came from a normal distribution. As displayed in Figure 3, the bilinguals (mean=568.2ms; standard deviation=59.8ms) were not significantly faster than the monolinguals (mean=570.7ms; standard deviation=72.6ms) on incongruent trials of the Flanker task, $t(36)=1.07, p=.916$.

Figure 2: Scatterplot of incongruent response times for Flanker task (ms) over self-assessed amount of English L2 use in daily life (%) in bilinguals (n=28).



Finally, to see whether only bilinguals with high L2 use are afforded enhanced executive control, another independent samples t-test examined whether there was a difference between a selected group of the highest L2 user bilinguals (n=11; mean=537.9ms; standard deviation=45.9ms) and the monolinguals (n=10; mean=570.7ms; standard deviation=72.6ms). The bilinguals L2 use ranged from 40%-80% in this group; however, no significant difference was revealed between these groups ($p=.226$)

Figure 3: Bar graph displaying mean incongruent response times (y-axis) in bilinguals versus monolinguals (x-axis)



4. DISCUSSION

Taken together, these results reveal that frequency of L2 daily use significantly predicted performance on incongruent trials of the flanker task in unimodal sequential bilinguals. L2 pronunciation proficiency was not found to be significant, although it had been

thought that “more challenging [articulatory] production demands” (1205) might have been associated with executive control [7]; nor was AoA significant, contrary to previous research [8]. Although a trend indicated that high L2 use bilinguals were faster overall on the incongruent trials of the Flanker task than monolinguals, no significant difference was revealed. In brief, the results underline that bilingualism, in all its forms, is a diverse experience, and that therefore the effect(s) bilingualism has on executive control in bilinguals in comparison to monolinguals cannot be treated as a unitary phenomenon.

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