Switching meanings and forms: An ERP study on multilingual language processing in Mandarin-English bilinguals

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Introduction. A central question in theories of bilingual language comprehension is how people understand utterances with shifts between languages (i.e., *code-switching*[1]). Do code-switched words incur distinct costs during comprehension? Code-switches often lead to longer reaction times[2] and larger N400s,[3] an ERP measure of the ease of lexico-semantic access.[4] Recently, Yacovone et al. (2021) proposed that these costs can be understood within a broader, predictive processing framework. Specifically, the authors used the *Storytime Paradigm* to test early Spanish-English bilinguals. They found an under-additive interaction between contextual fit and language in the N400 time window, suggesting that participants predicted the form of the upcoming word in the matrix language. They also found a late positivity for code-switched words (Spanish words in an English story), suggesting that the switch was detected only after the prediction was confirmed or disconfirmed. The present study explores whether these findings generalize to another population: Mandarin-English bilinguals from [REDACTED].

Methods. We recorded EEG from 17 Mandarin-English bilinguals (M_{age} = 24 yrs) while they listened to a 30-minute story in English with occasional Mandarin code-switches. Specifically, we took 102 predictable nouns (M_{cloze} = 77.1%, *Range* = 43–100%) and manipulated them to be the expected English word, a less expected English word, or the Mandarin equivalents of those words (see Table 1). All target words were spliced into the original recording, and the conditions were counterbalanced across four lists.

Predictions. We pre-registered linear mixed effects models assessing the interaction between *Language* (English vs. Mandarin) and *Contextual Fit* (Strong vs. Weak) on both N400 and P600 responses. If Mandarin-English bilinguals predict the form of the upcoming word in the matrix language, we expect an interaction with similarly sized N400s in all violation conditions. If not, we expect additive effects of *Language* and *Contextual Fit* such that *Mandarin Weak-fit* words evoke larger N400s compared to the other two violation conditions. On both hypotheses, we expect code-switches to produce P600s as a result of having detected the form violation.

Results. Data collection is ongoing (Target N = 40, Current N = 17), but we will present our preliminary findings (see Figure 1). *N400:* We find a main effect of *Language* (b = 1.31, t = 2.78, p = .012) and a trending effect of *Contextual Fit* (b = 0.88, t = 2.01, p = .061) with no apparent interaction (p = .637). *P600:* We find a main effect of *Language* (b = 2.73, t = 3.34, p < .01).

Discussion. These preliminary findings diverge from those observed in Spanish-English bilinguals. Specifically, the additive N400 effects are inconsistent with Yacovone's form-based prediction account. We see three possible explanations: First, this could reflect the perceptual distance between the switch language and the matrix language—Chinese words in an English context may be detected as mismatches faster than Spanish words (or *English Weak-fit* words), resulting in early language effects on the N400. Second, these differences could be the result of the different language histories of our participants. Participants in the prior Spanish-English study began learning English, on average, before age 4 via immersion contexts, and they were English-dominant at the time of participation. Our bilinguals were also early exposed to English (Mean = 4.76 yrs), but 59% learned in a classroom setting in China while the others lived and used English in the US and Singapore—and critically, only 30% self-reported as being English-dominant at the time of participation. Thus, we might expect prediction in English to be weaker in our sample.[6] Finally, our findings might simply result from different processing strategies used by our two exposure groups. Future analyses will explore this possibility further by splitting participants according to their English proficiency and age of acquisition.

Table 1. Example sentences from the story.

Condition	Example Sentence
English StrongFit	Tully ran outside to get on the bus and headed to **school.**
English WeakFit	Tully ran outside to get on the bus and headed to **work.**
Mandarin StrongFit	Tully ran outside to get on the bus and headed to 学校 **xuexiao.**
Mandarin WeakFit	Tully ran outside to get on the bus and headed to 工作 **gongzuo.**

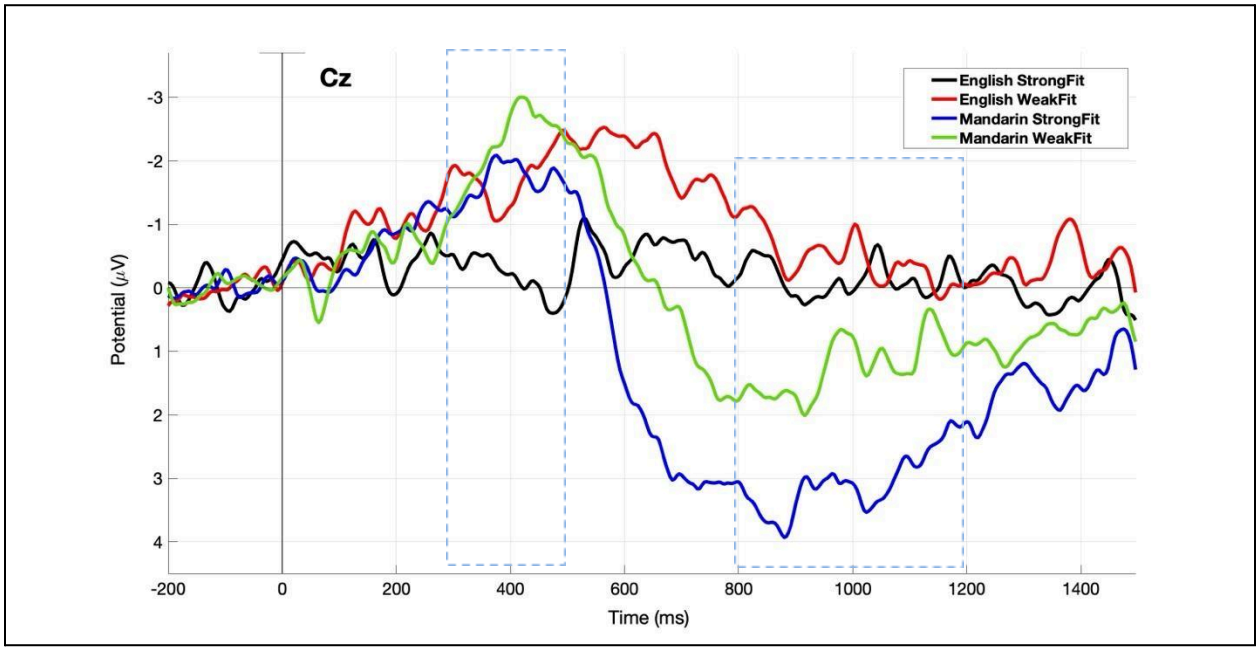

Figure 1. Grand average waveforms across word types (Language and Fit) from electrode Cz.

References **[1]** Poplack, 1980; **[2]** Ito et al., 2018; **[3]** Wicha et al., 2004; **[4]** Kutas & Federmeier, 2011; **[5]** Yacovone et al., 2021; **[6]** Ito & Pickering, 2021