

Bilinguals can predict upcoming ecological code-switches when given enough context

When bilinguals communicate with each other, they often “code-switch,” fluidly shifting between their shared languages. Given the psycholinguistic evidence that language comprehension is incremental and predictive (e.g., [1]), code-switches might add difficulty to the comprehension process, for example by adding variability and contradicting language-specific predictions about upcoming input. Indeed, much research on the comprehension of code-switches has demonstrated *switch costs*, showing that bilingual comprehenders generally are slower to process code-switched sentences than single-language equivalents (e.g., [2]).

However, code-switches do not seem to impede everyday bilingual conversations, and some studies suggest that more ecological code-switches evoke little or no switch costs [3, 4]. In psycholinguistic experiments, bilinguals often are presented with isolated code-switches that lack interactive cues and context. However, in everyday conversations, bilinguals may integrate their social and linguistic knowledge—of the topic of conversation, the speaker’s identity, when code-switches typically occur, and how speech typically changes leading up to a switch (e.g., [5])—to predict when code-switches are likely to occur and seamlessly process them. Thus, ***we predicted that, when listening to actual bilingual conversations (as opposed to isolated experimental stimuli), bilinguals would be able to predict upcoming code-switches***, indicating that those ecological code-switches likely are *not* costly to process. That is, we hypothesized that bilinguals can accurately discriminate naturally produced utterances with an upcoming code-switch from those with no upcoming code-switch.

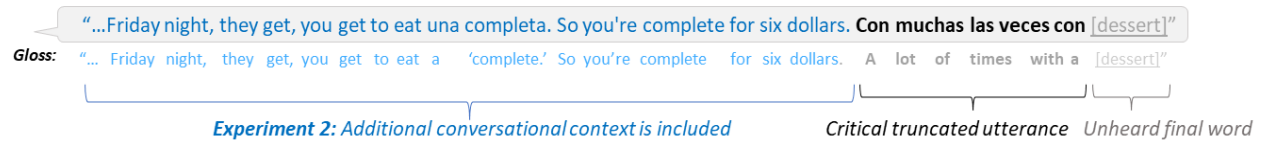
Method: In two pre-registered experiments, Spanish-English bilingual adults listened to 60 snippets of natural bilingual conversations extracted from a corpus of informal conversations between Spanish-English bilinguals [6]. Each snippet was a Spanish utterance with the final word removed. The unheard final word of half of these utterances code-switched to English, whereas the other half stayed in Spanish (with these switched and un-switched critical utterances matched on a number of characteristics such as utterance length; see Figure 1). ***After hearing each critical sentence fragment, participants were asked whether they thought the unheard final word would be in English or Spanish.***

In **Experiment 1** (N=115 after pre-registered exclusion criteria), participants *only* heard the critical truncated utterance (averaging 2.6 seconds in length), whereas in **Experiment 2** (N=94 after pre-registered exclusion criteria), they heard 30 seconds of the conversation leading up to the final unheard word (including the critical truncated utterance). For both experiments, we calculated participants’ ability to discriminate upcoming code-switches from non-switches with *d*-prime, where values above zero indicate successful discrimination and values above four indicate near perfect discrimination.

Results: In Experiment 1, where they heard only the critical sentence fragment, bilinguals were *not* able to predict upcoming code-switches, even though the code-switches were naturally produced (mean *d* prime=-0.04, *p*=0.20; see Figure 2A). However, with the additional context in Experiment 2, bilinguals *were* able to predict upcoming code-switches from Spanish into English above chance (mean *d* prime=0.42, *p*<0.001; see Figure 2B), as hypothesized.

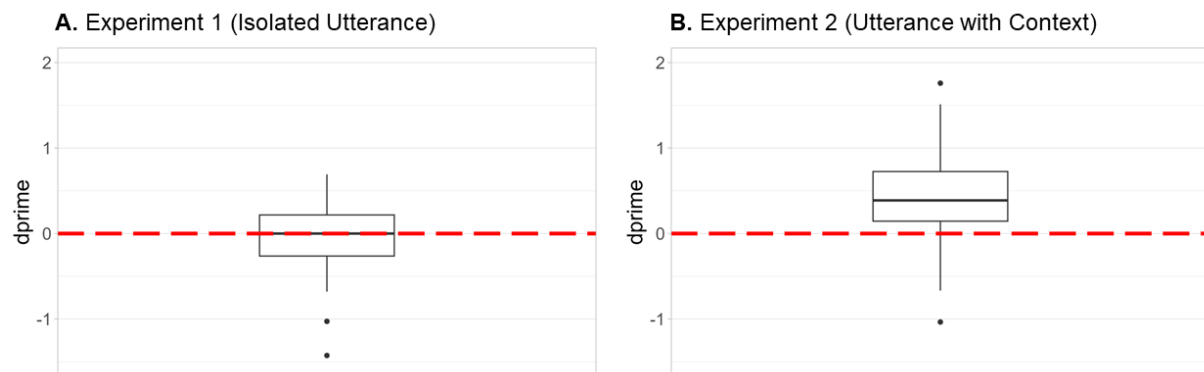
Conclusion: Our experiments demonstrate that ***bilinguals are able to accurately predict upcoming ecological code-switches when given sufficient conversational context***, which is often removed in psycholinguistic experiments. Exactly what cues bilinguals use (and when those cues optimally guide listeners) to predict upcoming code-switches remains an open question; however, our results indicate that exposure to the speaker and/or the conversational context is important. Overall, our findings suggest that contextualized, ecological code-switches are likely *not* very difficult to process. Thus, past work may overestimate switch costs in bilingual comprehension and underestimate the importance of social and contextual cues that are present in everyday bilingual conversations.

Figure 1. The experimental task.



Note. In Experiments 1 & 2, the critical truncated utterance (shown in bold black font here) is heard, and participants must predict which language the unheard final word would be in (Spanish or English). In Experiment 2 only, additional conversational context is added (shown in blue font here) such that participants could hear 30 seconds of preceding context before the unheard final word.

Figure 2. Bilinguals' ability to detect upcoming code-switches in naturally produced utterances.



Note. Boxplots of individuals' d prime values. The red dotted line indicates a d prime of zero, at which participants cannot reliably detect code-switches. Higher d prime values indicate better detection of upcoming code-switches. In Experiment 1, the mean d prime was -0.04 (95% CI: -0.11, 0.02) and overall mean accuracy was 49.58%. In Experiment 2, the mean d prime was 0.42 (95% CI: 0.32, 0.52) and overall mean accuracy was 56.02%.

References

- [1] Allopenna, P. D., Magnuson, J. S., & Tanenhaus, M. K. (1998). Tracking the time course of spoken word recognition using eye movements: Evidence for continuous mapping models. *Journal of Memory and Language*, 38(4), 419-439.
- [2] Bultena, S., Dijkstra, T., & Van Hell, J. G. (2015). Language switch costs in sentence comprehension depend on language dominance: Evidence from self-paced reading. *Bilingualism: Language and Cognition*, 18(3), 453-469.
- [3] Kaan, E., Kheder, S., Kreidler, A., Tomić, A., & Valdés Kroff, J. R. (2020). Processing code-switches in the presence of others: An ERP study. *Frontiers in Psychology*, 11, 1288.
- [4] Salig, L. K., Valdés Kroff, J. R., Slevc, L. R., & Novick, J. M. (2023). Linking frequency to bilingual switch costs during real-time sentence comprehension. *Bilingualism: Language and Cognition*, 1-16.
- [5] Fricke, M., Kroll, J. F., & Dussias, P. E. (2016). Phonetic variation in bilingual speech: A lens for studying the production-comprehension link. *Journal of Memory and Language*, 89, 110-137.
- [6] Deuchar, M, Davies, P, Herring, J, Parafita Couto, MC and Carter, D. (2014). Building Bilingual Corpora. In E. Thomas & I. Mennen (Eds.), *Advances in the study of bilingualism* (pp. 93-110). Multilingual Matters, Bristol.