Shared syntax in bilinguals: Does code-switching affect the strength of cross-language structural priming?

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Introduction: When bilinguals hear a certain grammatical structure in one language, they then become more likely to use that same structure when speaking their other language [1,2]. This phenomenon is known as cross-language structural priming. It has been argued, however, that the way bilinguals mix their languages often does not follow the script of typical cross-language priming experiments [3]. They not only switch languages between sentences but also within sentences. Both code-switching and cross-language structural priming are commonly interpreted as evidence that syntactic knowledge of two different languages is in some way shared in the language system of bilinguals [1,4,5]. We test the hypothesis that intra-sentential code-switching increases sharing of syntax in bilinguals in a way that leads to a stronger structural priming effect compared to cross-language structural priming without code-switching in the prime sentence. We also test whether this interaction can be explained as the result of implicit learning as implemented in the Dual-path model [6]. Following the computational modeling work, we conduct a behavioral experiment with Spanish-English bilinguals.

Simulated experiments. We performed simulated experiments using the Bilingual Dual-path model [7]. This model was used to demonstrate that human-like code-switches can be produced by an implicit learning model even when it was not trained on code-switched input. Furthermore, it has been shown that the model can cross-language structural priming [8]. In our simulations we followed the simulated experimental paradigm from that study. We trained model instances on artificial versions of Spanish and English, and used these as simulated participants. The simulated participants received more input in English than in Spanish to simulate the English-dominant bilinguals that we plan to recruit as participants.

Results. Here we report on the first two of six preregistered simulated cross-language structural priming experiments (https://aspredicted.org/blind.php?x=FZF_XRH). In both of these simulations, the model was first presented with an active or passive prime sentence in Spanish. This prime sentence either had an English (code-switched) determiner and noun (a,b), or was entirely in Spanish (c). In the first simulation, the code-switch was at the beginning of the sentence (a), while in the second simulation it was at the end of the sentence (b). When the code-switch was at the beginning of the sentence, the presence of a code-switch increased the strength of the structural priming effect compared to primes without a code-switch (Fig. 1). In contrast, when the code-switch was at the end of the sentence, priming seemed to be weaker compared to primes without a code-switch (Fig. 2). Analyses using logistic mixed effects models revealed a significant positive interaction between code-switch condition and priming for the first simulation (Est. = 0.06, p = .022), but a non-significant negative interaction between those two predictors in the second one (Est. = -0.04, p = .107). These results indicate that cross-language structural priming in the model increased in strength after a code-switch from English, the dominant language, to Spanish, but not when the code-switch was in the other direction.

Looking forward. Our study will continue in three steps. First, we will conduct the remaining four preregistered simulations to determine whether the same pattern of results occurs when the code-switch consists either of a noun only or of a determiner, an adjective, and a noun. With what we learn from these simulations, we will conduct a cross-language priming experiment with Spanish-English bilinguals who will describe pictures after hearing recorded code-switched and non-code-switched prime sentences. Further simulations are also planned that address two limitations of the simulations that have been preregistered so far: In contrast with the bilinguals who will participate in the experiment, the model instances that we use as simulated participants were only trained on sentences in a single language and thus never processed code-switched sentences before. Also, code-switching was not activated in the model during production of the target sentence, whereas participants will not be instructed to produce

only single language sentences during the experiment. By addressing these two issues might enable us to more closely model the bilingual language production of our participants.

Example prime sentences:

(a) "***the girl*** empuja el juguete" (Code-switch at beginning of sentence)
(b) "la niña empuja ***the toy***" (Code-switch at end of sentence)
(c) "la niña empuja el juguete" (No code-switch)

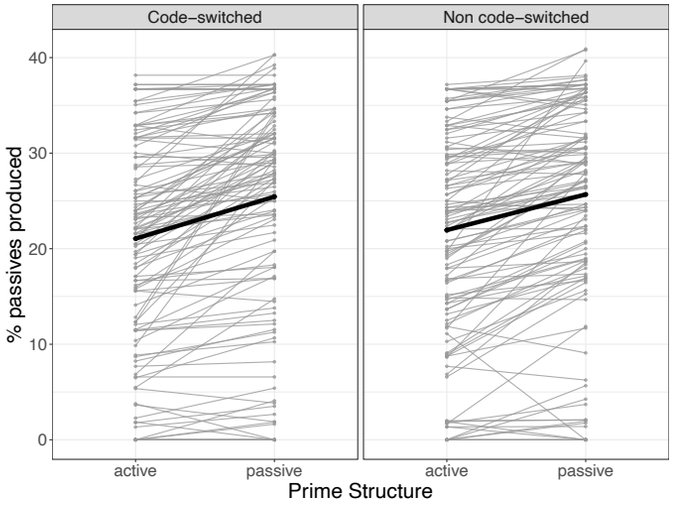

Fig. 1 *First simulated experiment, with code-switch at beginning of prime sentence (a).* Percentage of responses that had a passive structure after either an active prime (21.1%) or a passive prime (25.4%), for code-switched trials (on the left), and percentage of responses that had a passive structure after either an active prime (21.9%) or a passive prime (25.7%) for non-code-switched trials (on the right).

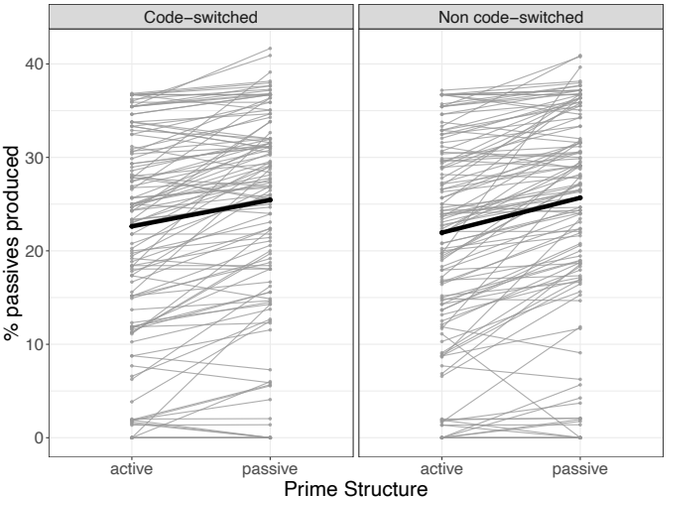

Fig. 2 *Second simulated experiment with code-switch at end of prime sentence (b).* Percentage of responses that had a passive structure after either an active prime (22.6%) or a passive prime (25.4%), for code-switched trials (on the left), and percentage of responses that had a passive structure after either an active prime (21.9%) or a passive prime (25.7%) for non-code-switched trials (on the right).

The thick black lines visualize the priming effect across all analyzed trials by connecting the percentage of passives responses after active primes to the percentage of passive responses after passive primes. The thin grey lines show the same for each individual simulated participant.

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