

Exploring Cross-Linguistic Effects in Sentence Reading Using Fixation-Related Potentials

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The multilingual language system does not consist of separate language systems that can be toggled on or off at will, instead, it is an integrated system. Syntactic priming from L1 into L2 provided early evidence for shared syntax [2]. An effect of L2 exposure on L1 attachment preferences similarly points in the direction of shared syntax [1]. We designed a co-registered eye-tracking and EEG experiment to investigate how processing in one language is affected by a bilingual's knowledge of another language's syntax.

Participants read sentences in Dutch and English. Each sentence item had an Easy condition, conforming to grammatical expectations (e.g., “Diana brought over some freshly baked homemade cookies for her grandma”), and a Hard condition, which did not (e.g., “Diana brought some freshly baked homemade cookies over for her grandma”). Each language had two target sentence types, where influence from the other language was expected to either increase or decrease the difficulty difference between the Easy and Hard conditions (see Supplementary Information). So, for example, for an English sentence where we would expect cross-linguistic influence from Dutch to increase the relative processing difficulty, we expected Dutch-English bilinguals to show a larger processing cost difference between the Easy and Hard condition compared to English monolinguals. This would be reflected in increased reading times in the eye-tracking data, and a stronger N400 effect in the EEG data when looking at fixation-related potentials.

We recorded data from 108 Dutch-English bilinguals, 23 English-Dutch bilinguals and 48 L1 English speakers with no knowledge of another Germanic language. We fitted mixed-effects regression models on the baseline-corrected N400 amplitude averaged across a time window of 300-500ms post-fixation on the critical word, and on the log-transformed first-pass reading time (RT) on critical words, for L1 data only. In both cases, the fixed-effects were $\text{Difficulty} \times \text{Language} \times \text{CLI}$, where CLI is the expected direction of cross-linguistic influence, i.e., an Increase or Decrease in the effect of Difficulty due to the other language. The interaction of main interest is $\text{Difficulty} \times \text{CLI}$ but here we report on initial, exploratory analyses to confirm if our basic manipulation was successful, i.e., whether the Hard condition was indeed harder to process than the Easy condition. Neither the N400 nor RT analysis showed a significant effect of Difficulty, although they were numerically in the expected direction (see Tables 1 and 2). We intend to run further explorative analyses to examine possible effects in the spillover region of the eye-tracking data, and to apply deconvolution [3] to the EEG data to allow us to look at later FRP components. If nothing else, this should allow us to inform future study designs aiming to make use of co-registered eye-tracking and EEG on what pitfalls to avoid.

References

- [1] P. E. Dussias and N. Sagarra. The effect of exposure on syntactic parsing in Spanish–English bilinguals. *Bilingualism: Language and Cognition*, 10:101–116, 2007. doi: 10.1017/S1366728906002847.
- [2] R. J. Hartsuiker, M. J. Pickering, and E. Veltkamp. Is syntax separate or shared between languages? cross-linguistic syntactic priming in Spanish-English bilinguals. *Psychological Science*, 15:409–414, 2004. doi: 10.1111/j.0956-7976.2004.00693.x.
- [3] C. Shain and W. Schuler. Continuous-time deconvolutional regression for psycholinguistic modeling. *Cognition*, 215:104735, 2021. doi: 10.1016/j.cognition.2021.104735.

Tables

	b	t	p
N400	−0.045	−0.77	.44
log(RT)	0.011	1.06	.29

Table 1: Estimated effect of Difficulty for analysis of N400 size and log(RT).

	Easy	Hard
N400	−0.28	−0.37
RT	211	216

Table 2: Estimated marginal means of N400 size (μV) and RT (ms) in the Easy and Hard Difficulty conditions.

Supplemental Information

Stimuli examples with explanations in each of the $2 \times 2 \times 2$ conditions, with critical words underlined:

Dutch items. Expected CLI: Increase

- Easy: “Welke speler heeft de teamgenoten omhelsd vanwege het doelpunt?”
Lit.: Which player has the team_mates embraced because_of the goal?
“Which player has embraced the team mates because of the goal?”
- Hard: “Welke spelers heeft de teamgenoot omhelsd vanwege het doelpunt?”
Lit.: Which players has the team_mate embraced because_of the goal?
“Which players has the team mate embraced because of the goal?”

In both languages, the NP after “Welke/Which” can be subject or object, with subject preferred. This expectation is violated by the singular verb in the Hard condition. Starting with an object-NP is more common in Dutch than in English, so influence from English should make the expectation violation more severe, increasing the difference between Easy and Hard sentences.

Dutch items. Expected CLI: Decrease

- Easy: “De studenten die de docent hebben geholpen bleven altijd geduldig.”
Lit.: the students that the teacher have helped stayed always patient
“The students that have helped the teacher stayed always patient”
- Hard: “De student die de docenten hebben geholpen bleef altijd geduldig.”
Lit.: The student that the teachers have helped stayed always patient
“The student that the teachers have helped stayed always patient”

Dutch “NP that NP” is ambiguous between a subject-relative (SR) and object-relative (OR) reading, with SR preferred. If the NPs differ in number, the verb disambiguates by agreeing with the subject. English “NP that NP” is always OR, so influence from English should make the OR reading easier, reducing the difference between Easy and Hard sentences.

English items. Expected CLI: Increase

- Easy: “The interviewer confirmed that the meeting would not run too late.”
- Hard: “The interviewer confirmed the meeting would not run too late.”

Dutch does not allow dropping the complementizer “that”, so influence from Dutch should make it harder to understand “the contract” as the subject of a sentence complement in the Hard condition, increasing the difficulty difference between Easy and Hard sentences.

English items. Expected CLI: Decrease

- Easy: “Diana brought over some freshly baked homemade cookies for her grandma.”
- Hard: “Diana brought some freshly baked homemade cookies over for her grandma.”

Dutch requires verb particles to be placed after the object, so influence from Dutch should make the occurrence of the particle less unexpected in the Hard condition, decreasing the difficulty difference between Easy and Hard sentences.