

The impact of modality on temporal linguistic processing: a comparison of spoken and signed languages

Chiara Luna Rivolta^{1,2}, Brendan Costello¹, Manuel Carreiras^{1,2,3}

¹Basque Center on Cognition, Brain and Language (BCBL); San Sebastián, Spain

²University of the Basque Country (UPV-EHU); Bilbao, Spain

³Ikerbasque, Basque Foundation of Science; Bilbao, Spain

crivolta@bcbl.com

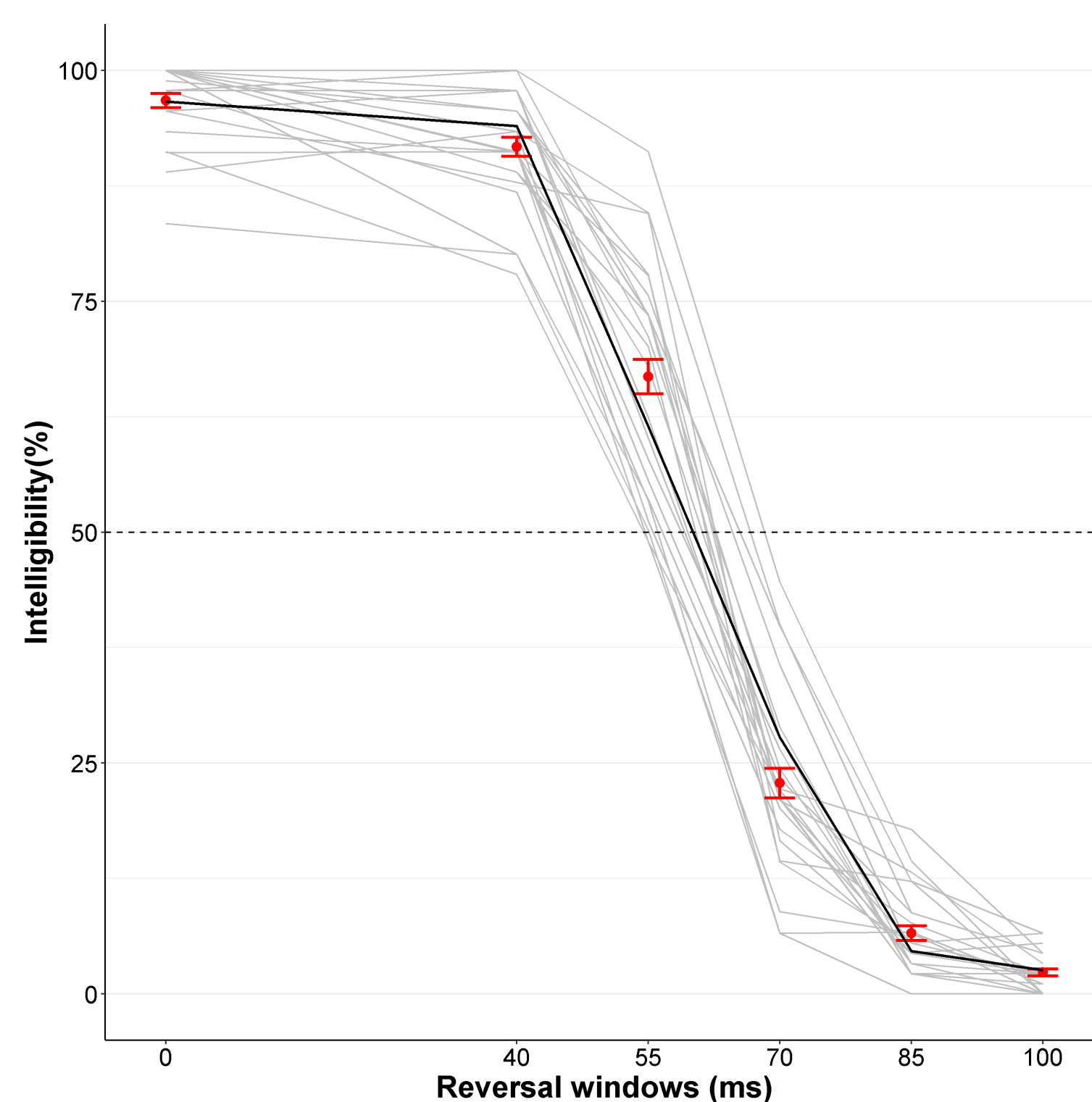
INTRODUCTION

Language comprehension relies on **temporal parsing** of incoming information. Spoken and signed languages share all fundamental language properties; but differ in **modality** (acoustic and visual) and **temporal structure**. The experiment investigates the impact of modality and language temporal structure on how our **cognitive system processes linguistic information**.

RESULTS

Spoken language

Intelligibility ~ Reversal window * Repetition time + Baseline + (1 | Item) + (1 | Participant)



Sign language

Intelligibility ~ Reversal window + Baseline + (1 | Item) + (1 | Participant)

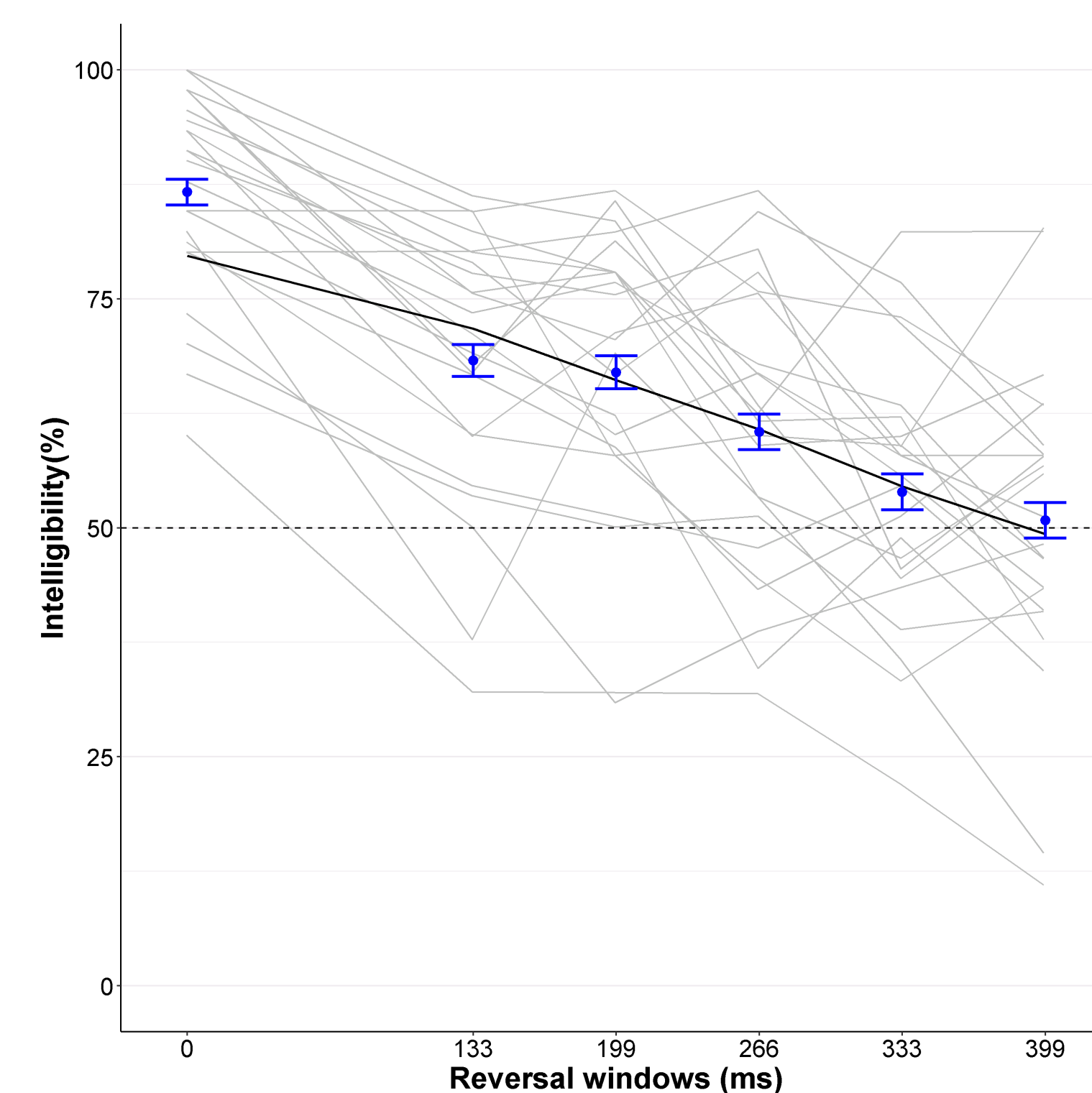


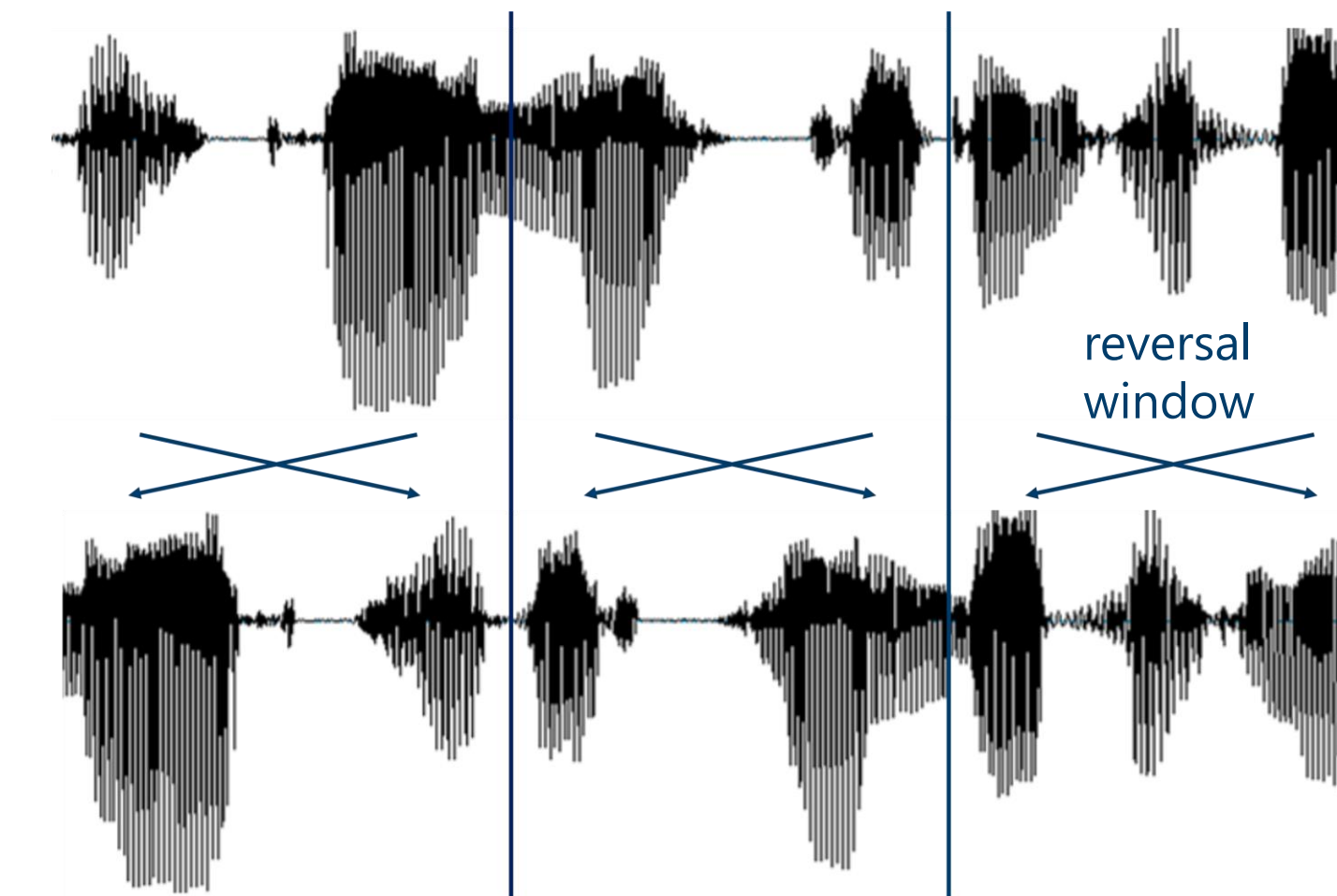
Figure 1,2 show the intelligibility curve as a function of reversal window size for Spanish (left) and LSE (right). Grey lines represent observed data by participant, while the black line show predicted values for spoken language ($R^2 = 0.850$) and sign language ($R^2 = 0.485$) models. In the spoken language model a cubic term (reversal window³) was added.

Intelligibility drops under 50 % at 60-65 ms reversal window, showing a clear point after which language processing is lost.

Intelligibility gradually decreases with longer reversal windows; no clear temporal integration window of interest can be identified.

METHOD

Manipulation: Locally time-reversed speech. Longer reversal windows lower intelligibility of the signal



Reversal windows: Reversal windows were chosen based on previous studies on spoken languages (Ueda et al., 2017) and the only study (Hwang, 2011) which extended this paradigm to a signed language (American Sign Language)

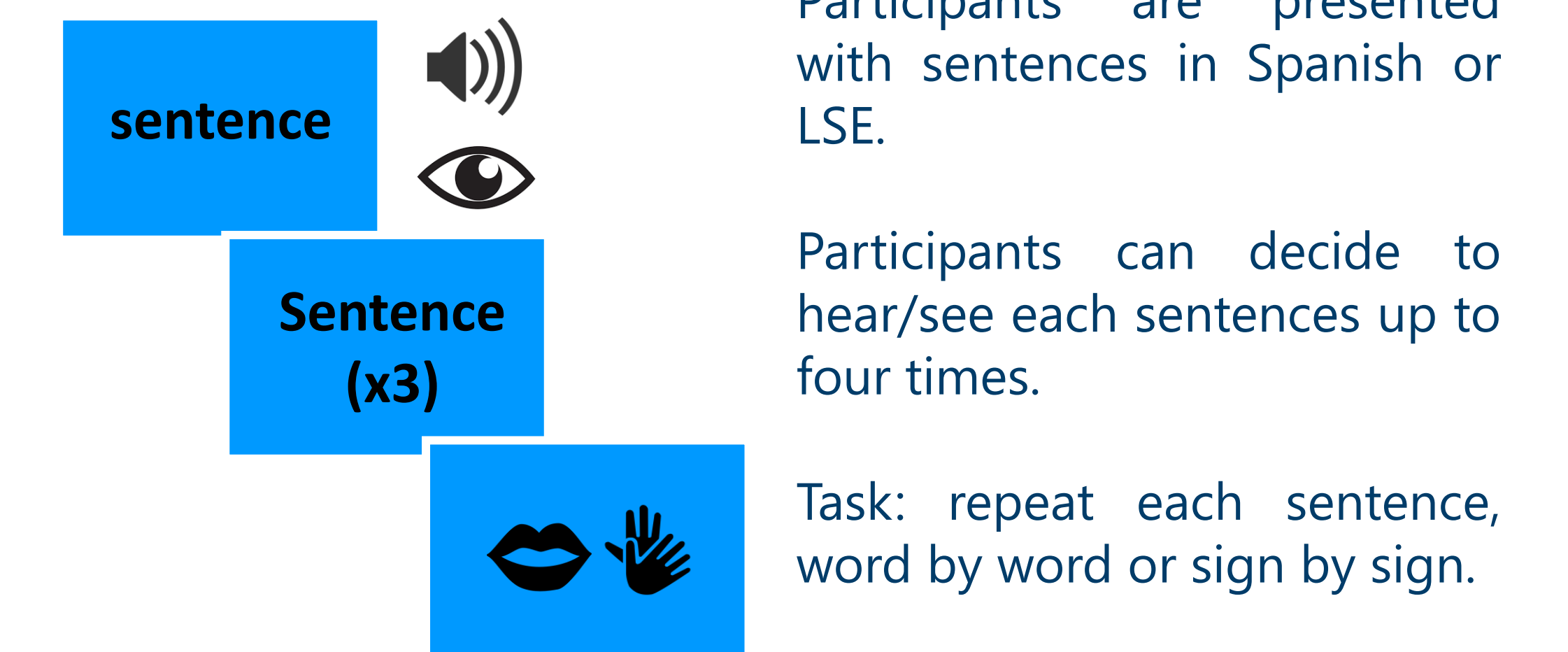
Spanish	0 ms	40 ms	55 ms	70 ms	85 ms	100 ms
LSE	0 ms	133 ms	199 ms	266 ms	333 ms	399 ms

Click to see examples of the stimuli.

Participants: 22 highly proficient bimodal bilinguals in Spanish and Spanish Sign Language (LSE).

Material: 60 semantically unpredictable sentences in each language.

Procedure:



Accuracy was calculated based on the number of words/sign repeated in the correct order.

CONCLUSIONS

Results in Spanish reproduce previous studies (Ueda et al., 2017), confirming that temporal processing employs the same mechanism across different spoken languages.

Results in LSE reproduce those found in ASL (Hwang, 2011).

LSE is more resilient to temporal distortion than spoken languages are; this might be due both to the nature of visual processing and sign language specific temporal structure.

Language intelligibility as a function of temporal distortion shows different patterns depending on language modality. The results suggest that there is no universal mechanism to process the temporal structure of the language signal, but that **our cognitive system adapts** depending on the specific characteristics of spoken and signed languages.