The comprehension of SRCs and ORCs in LIS: an eye-tracking study

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Introduction. The literature supporting the universality of the subject advantage predicted by the Noun Phrase Accessibility Hierarchy (Keenan & Comrie 1977) mainly includes studies investigating the processing of subject (SRCs) and object relative clauses (ORCs) in L1 speakers of Indo-European languages (see Lau & Tanaka 2021 for overview) displaying externally headed relative clauses (EHRCs). Interestingly, the scarce literature addressing the production of relative clauses in children and adult L2 learners of languages displaying both EHRCs and internally headed relative clauses (IHRCs), such as Korean (e.g. Kim 1987; Jeon & Kim 2007) and Cantonese (e.g. Yip & Matthews 2007), casts doubt on the validity of the subject advantage across languages, relative clause types and populations, by showing that the internally headed strategy is selected to avoid the complexity of ORCs, while EHRCs are used for SRCs. These studies suggest a correlation between relative clause typology and syntactic complexity, assuming that the internally headed typology is syntactically easier, thus asymmetries between SRCs and ORCs are less expected or can be harder to detect. The pioneering study by Hauser et al. (2021) sheds new light on this domain by comparing the comprehension of SRCs and ORCs across three populations of Deaf signers (natives, early and late learners) through a picture-matching task in three typologically different sign languages: French Sign Language (LSF) displaying EHRCs, Italian Sign Language (LIS) and Catalan Sign Language (LSC) featuring IHRCs. Results reveal a clear subject advantage in LSF and LSC, while in LIS the asymmetry only surfaces in Deaf late signers (exposed to LIS between 6 and 15 yo). All in all, these findings show that the subject advantage might be harder to detect in IHRCs since it surfaced only in "special" populations. Therefore, more experiments adopting different methods and involving different populations are needed. Further research on this domain can also contribute to the theoretical debate about the source (e.g. cue-based or structure-based) of the subject-object asymmetry. The present study aims at filling these gaps by investigating the processing of internally headed SRCs and ORCs in LIS, through a time-sensitive method, across three populations of adults: Deaf native signers (exposed to LIS from birth), Deaf non-native signers (exposed to LIS after 1 yo), and LIS/Italian CODAs (Children of Deaf Adults), namely hearing individuals who acquired LIS (from their Deaf parents) and Italian from birth. CODAs' linguistic abilities are particularly interesting to study since LIS and Italian vary greatly in their grammars: LIS is a SOV language featuring IHRCs, while Italian is a SVO language displaying EHRCs.

Goals. The goal of this study is two-fold: (i) to assess the asymmetry between subject and object relative clauses in a sign language displaying the internally headed strategy using an eye-tracking paradigm; (ii) to investigate whether the asymmetry is found across different populations of signers.

The study. The study adopts the eye-tracking Visual-only World Paradigm adapted to sign language by Hauser & Pozniak (2019). In this paradigm, the participant simultaneously sees two pictures representing the same event involving the same referents (albeit with inverted theta roles) and a slowed-down video of a signed subject or object relative clause on a computer screen. (1) and (2) exemplify the LIS relative clauses that we used as stimuli.

(1) SRC: IX_2 PRINCESS LOOK_AT. [$PRINCESS_i$ FENCER DRAW PE_i] (IX_2) CHOOSE

'Please find the correct princess, that is the princess that draws the fencer.'

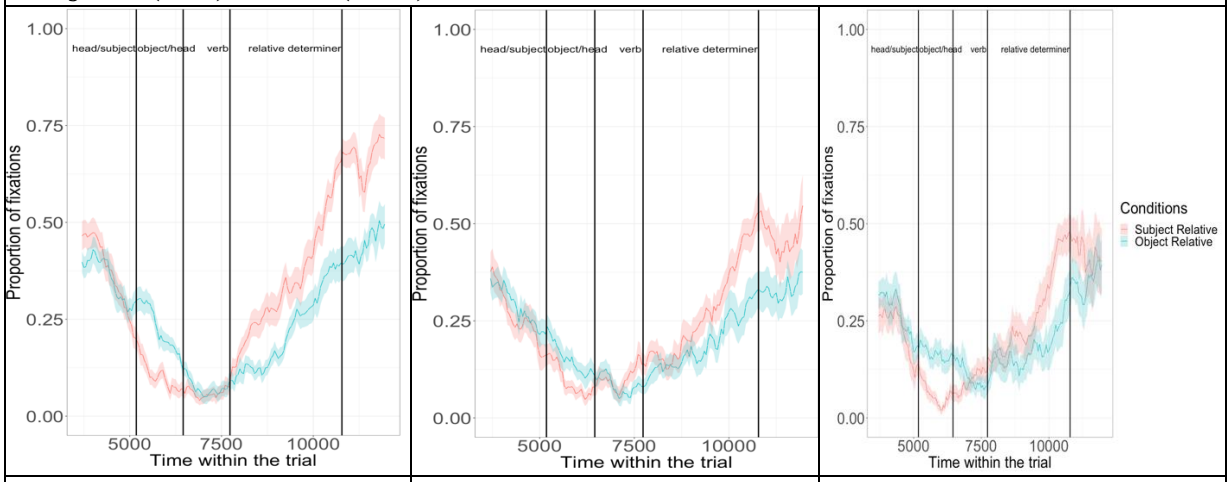
(2) ORC: IX$_2$ PRINCESS LOOK_AT. [FENCER PRINCESS$_i$ DRAW PE$_i$] (IX$_2$) CHOOSE
'Please find the correct princess, that is the princess that the fencer draws.'

Participants are asked to select the correct picture corresponding to the video stimulus by fixating the gaze on it as soon as they are certain of the correct answer, and to confirm their answer by pressing the left or right button on a response device once the video ends. In so doing, both online (eye data - recording starts at the onset of the relative clause and ends at the offset of the relative determiner "PE") and offline (button accuracy) responses are recorded. We collected data from 17 Deaf native signers (mean age: 35,57 yo; SD: 9,34), 13 Deaf non-native signers (mean age: 36,73 yo; SD: 8.81), and 21 CODAs (mean age: 38,23 yo; SD: 11,51).

Results. The eye-tracking data show a clear difference across RC types for CODAs (interaction between Time and relative clauses type: Est.= 0.01, t=25.05, p<1.25^{e-137}), with the correct answer being fixated earlier and more accurately in SRCs than ORCs (Tab. 1a), whereas no asymmetry is observed in Deaf native (Tab. 1b) and non-native signers (Tab. 1c).

Tab. 1 Eye-tracking data

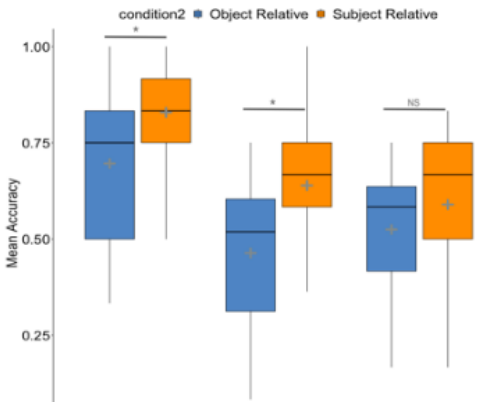
Black bars indicate mean position of sentence elements for both SRC and ORC, from left to right: head$_{(src)}$/subject$_{(orc)}$; object$_{(src)}$/head$_{(orc)}$; verb; relative determiner. Time is sequenced in 50ms time bins within which the proportion of fixations to different areas is calculated: each data point represents the proportion of fixations that the correct picture received when seeing a SRC (in red) or an ORC (in blue).



a. CODAs | **b.** Deaf native signers | **c.** Deaf non-native signers

As for accuracy (Tab. 2), we found an asymmetry between the two conditions SRC and ORC across populations that is significative for CODAs (Est.=0.77, t=3.42, p<0.0006) and native signers (Est.=0.79, t=3.59, p<0.0003), with CODAs (Tab. 2a) outperforming both Deaf native (Tab. 2b) and non-native signers (Tab 2c).

Tab. 2 Accuracy data *(a: CODAs; b: Deaf native signers; c: Deaf non-native signers)*



a. | **b.** | **c.**

Discussion. The data show that a subject advantage is indeed detected in LIS internally headed relative clauses, albeit being more consistent and salient in CODAs, thus showing that the predictions of the Noun Phrase Accessibility Hierarchy hold across relative clause typologies (EHRC and IHRC), modalities (spoken and signed) and populations (here, CODAs and Deaf native signers). From a theoretical perspective, these findings show that the subject advantage in LIS cannot be explained by considering canonicity effects (e.g. Sekerina 2003) or linear distance (e.g. King & Just 1991), since ORCs are more difficult to understand despite displaying unmarked SOV word order and a shorter linear distance between the head and the head-marker PE (which identifies the head noun by spatially agreeing with it). Rather, our data provide evidence for the validity of structural accounts ascribing the source of the asymmetry between SRCs and ORCs to the structural distance between the head noun and the gap, and the dependency created through (overt or covert) movement of the head (e.g. Cole 1987; O'Grady et al. 2003). Indeed, although LIS relative clauses do not involve the overt movement of the noun head, they display the overt movement of the determiner PE from an adnominal position, next to the head noun (a clause-internal D-position), to a clause-external C-position in the right periphery of the relative clause (Branchini & Donati 2009; Branchini 2014). The dependency created by the movement of PE is longer and the structural position of the gap left by PE is more embedded when the head is the object, thus making ORCs more complex even within the internally headed type. To explain CODAs' better performances, we could look into so-called bilingualism-related cognitive advantages, such as enhanced cognitive and attentional control or faster attention swift (e.g. Bialystok et al. 2004; Sorace 2010; Ostadghafour & Bialystok 2021), that can make them better at performing such a complex task (here participants had to make decisions while watching simultaneously two sets of three characters plus a signed video). Additionally, bimodal bilingualism might also provide CODAs with the ability to transfer the metalinguistic knowledge of their spoken language (that they develop at school) to analyze the structures at play in their signed language in a more systematic way as compared to Deaf people, whose exposition to one or both languages is often delayed or reduced because of the lack of a bimodal bilingual (here, LIS-Italian) input in both private and socio-educational contexts.

Conclusions. This is the first eye-tracking study assessing the subject-object asymmetry in a sign language featuring IHRCs and the first study to test the comprehension of complex structures in bilingual CODAs. Our results confirm the predictions of the Noun Phrase Accessibility Hierarchy advanced for spoken languages and the validity of structural accounts to explain the subject-object asymmetry, while also raising interesting questions regarding a possible advantage of bimodal-bilingualism in understanding complex sentences.

Selected references. **Branchini, C. 2014**. On relativization and clefting. An analysis of Italian Sign Language (LIS). Berlin: De Gruyter Mouton. **Hauser, C., Pozniak, C. 2019**. Relative clauses processing in LSF: an eye-tracking innovative experiment. Poster presented at AMLAP 2019th Moscow. **Jeon, S., Kim, H. 2007**. Development of relativization in Korean as a foreign language. Studies in Second Language Acquisition 29(2). 253–276. **Ostadghafour, S., Bialystok, E. 2021.** Comprehension of complex sentences with misleading cues in monolingual and bilingual children. Applied Psycholinguistics 42, 1117–1134.