Research in Generative Grammar
RGG 2025.10
Rivista di Grammatica Generativa

The interpretation of ambiguous *which*-questions in Italian Sign Language (LIS)

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Abstract. Crosslinguistic studies on the comprehension and production of *wh*-questions in spoken languages report an advantage for subject over object clauses. To date, very few studies have been carried out to investigate the presence and direction of the alleged subject/object asymmetry of *wh*-questions in sign languages. The present study analyses the comprehension of Italian Sign Language (LIS) *wh*-questions, featuring the *wh*-sign WHICH, through a sentence-to-picture matching task administered to three groups of participants: hearing native signers (so-called CODAs), deaf native signers, and deaf non-native signers. The task investigates two types of structures: potentially ambiguous *which*-questions displaying the stranding of the nominal restrictor, and *which*-questions featuring a disambiguating strategy. Results show a preference for an object interpretation both in ambiguous and unambiguous *which*-questions driven by animacy features.

Keywords. *Wh*-questions, Italian Sign Language, subject/object asymmetry, language acquisition

Cite as: Branchini, Chiara, Alessia Bongiorno & Gianluca E. Lebani & Lara Mantovan. 2025. The interpretation of ambiguous *which*-questions in Italian Sign Language (LIS). *RGG*, 47(10). pp. 1–40. Lingbuzz Press.

1 Introduction

A marked subject/object asymmetry in the comprehension and production of *wh*-questions, with subject (1) being easier than object (2) *wh*-questions, is a robust phenomenon attested in the online and offline cross-linguistic studies investigating adults' competence (e.g., De Vincenzi 1991; Penolazzi et al. 2005, a.o.), language acquisition (e.g. Yoshinaga 1996; De Vincenzi et al. 1999; Van Der Lely & Battell 2003; a.o.), language impairment and hearing loss (e.g., Dickey, Choy & Thompson 2007; Garraffa & Grillo 2008; Friedmann & Haddad-Hanna 2014; D'Ortenzio & Volpato 2020, a.o.).

(1) Who <who> hugs the child?

(2) Who does the child hug <who>?

Different proposals have been advanced to account for the asymmetry capitalising on linear order (Diessel & Tomasello 2005), on the linear distance between the gap[1] and the moved *wh*-operator (De Vincenzi 1991; O'Grady 1997), on the structural distance holding between them (Hawkins 1999), and on intervention effects (Rizzi 1990; Friedmann, Belletti & Rizzi 2009).

The persistence and strength of the asymmetry changes and is modulated by different syntactic and semantic features across world languages (see Avrutin 2000 for English; Stavrakaki 2006 for Greek; Guasti et al. 2012 for Italian; Friedmann, Belletti & Rizzi 2009 for Hebrew, a.o.).

The vast majority of the literature concentrates on spoken languages featuring movement of the *wh*-phrase to the left of the sentence, and, to a lesser degree, displaying the *wh*-phrase *in situ*. As a consequence, the proposals advanced to account for the observed asymmetry are shaped after, and potentially misguided, by this very subset of languages.

A substantial, yet still understudied, group of languages whose peculiar feature is to display the *wh*-phrase at the right, rather than at the left, of the sentence is left out of the picture. This is the case of sign languages, whose description and syntactic representation are growing, but whose research for an alleged subject/object asymmetry is, to our knowledge, still scarce.

The discussion is very relevant both at the level of typological description and theoretical analysis. On the one hand, typological description

1. Indicated with '<who>' in the examples.

enriches our knowledge of features shared by world languages, as well as cross-linguistic differences allowed by the language faculty regardless of the linguistic modality employed (oral-auditory vs. visual-manual). On the other hand, the solidity of theoretical proposals needs to be tested against languages displaying properties not, or rarely, observed in spoken languages, as is the case of languages employing a different modality.

The present study marginally addresses the issue by looking at a peculiar set of *wh*-questions in Italian Sign Language (LIS) featuring the stranding of the nominal restrictor, a structure potentially triggering ambiguity between a subject and object reading (3).[2]

(3) CHILD CANDY BUY WHICH
'Which child buys the candy?'
'Which candy does the child buy?' (LIS)

In 3, the ambiguity arises as both NPs are possible candidates for the lexical restrictor of the *wh*-element. Depending on the reconstruction site of the latter (i.e., in subject or object position), the sentence turns into a subject or object question. By administering a comprehension task to three populations of signers (hearing native signers, so-called CODAs – Children Of Deaf Adults, deaf native signers, and deaf non-native signers) we aim at verifying the preferred interpretation of ambiguous LIS *wh*-questions of the type in (3). We further investigate which, among the disambiguating strategies proposed, are most effective across the three populations of signers taken into consideration.

The paper is organised as follows. Section 2 focuses on spoken languages by providing: (i) a brief description of the cross-linguistic features displayed by *wh*-questions (§2.1); (ii) the theoretical proposals advanced for their syntactic representation (§2.2); and (iii) the core discussion on the subject/object asymmetry observed in *wh*-questions (§2.3). §3 concentrates on sign languages: §3.1 offers a cross-linguistic description of *wh*-questions; §3.2 sums up the theoretical approaches to their syntactic derivation; §3.3 presents the main findings on the subject/object asymmetry on *wh*-questions in sign languages. §4 is devoted to the experimental study. We present the research questions and predictions (§4.1), the participants involved (§4.2), and the experimental design (§4.3). Data analysis, results, and discussion are provided in §4.4, §4.5, and §4.6, respectively. §4.7 presents some limitations of the study, §4.8 opens to future research topics and §5 draws the conclusions.

2. Following standard conventions, glosses for signs are in small caps.

2 *Wh*-questions: a glance at spoken languages

2.1 Typological differences

The defining property of *wh*-questions (or content interrogatives) is the presence of a word expressing interrogative meaning (henceforth the *wh*-phrase) whose interpretation yields the answer to the question, which is open. This type of question shows cross-linguistic variation as to the position occupied by the *wh*-phrase that, in the vast majority of spoken languages, can either correspond to its grammatical function, i.e., *in situ*, as in Japanese (4), or be dislocated at the left periphery of the sentence, as in English (5).[3]

(4) John-wa **nani**-o yonda-no?
John-TOP what-ACC read-Q
'What did John read?' (Cheng 2003: 108)

(5) **Why** does Kelly teach maths?

Interestingly, the possibility of finding the *wh*-phrase at the right periphery of the sentence seems to be extremely rare in spoken languages.[4]

Regardless of its position, the *wh*-phrase always plays a grammatical function in the sentence: it can be one of the verb's arguments (the subject, as in (1), the direct object, as in (2), or an adjunct, as in (5). Languages vary as to the type of *wh*-items displayed and to the possibility for the *wh*-item to have a nominal restrictor. Languages displaying a nominal restrictor may allow for movement of the nominal restrictor and the *wh*-item (so-called pied-piping, as in (6) and/or movement of the *wh*-item alone leaving its nominal restrictor *in situ* (so-called stranding, as in (7)).

(6) [**Which car**]$_i$ did you buy [t$_i$]?

3. We leave aside the case of languages allowing for multiple question words, as not directly relevant for the present study.

4. Cecchetto, Geraci & Zucchi (2009) report the presence in the literature of some spoken languages displaying the *wh*-element at the right periphery, as Tangale and Ngizim, two Chadic languages spoken in North-Eastern Nigeria (Kenstowicz 1987, Tuller 1992), some Romance dialects, whose occurrences are restricted to internal arguments and adjuncts (Poletto & Pollock 2004) and Tennet, a Nilo-Saharan language spoken in Sudan (Dryer 2009).

(7) **Kavka**$_i$ si kupio [t_i **kola**]?
which have-AUX.2SG buy-AUX.PTCP.2SG car
Which car did you buy? (Serbo-Croatian, Bošković 2005: 3)

2.2 Theoretical approaches

Wh-questions are derived through the merging of the *wh*-phrase in the position it is interpreted (the *in situ* position). Languages dislocating the *wh*-phrase move it from the *in situ* position to an A-bar position, which, adopting a simplified cartographic representation, corresponds to the Spec,CP of the sentence. Hence its appearance at the left periphery in languages like English. The movement of the *wh*-phrase is motivated by the need to check the interrogative feature in C°, thus a dependency between the *wh*-operator and its gap in the *in situ* position is created (Chomsky 1977, 1981; Rizzi 1997). (8) shows the abstract derivation of an English subject *wh*-question, like (1).

(8) [$_{CP}$ *wh* [C°[$_{TP}$ ~~*wh*~~ [V [$_{VP}$ ~~*wh*~~ [~~V~~ O]]]]]]

When the *wh*-item displays a nominal restrictor, the complex *wh*-phrase (*wh*-item + NP) enters the derivation in the *in situ* position. Under pied-piping, the full *wh*-phrase moves toward the Spec,CP position at the left periphery of the sentence (9a), while in case of stranding, only the *wh*-item targets the Spec,CP position leaving its nominal restrictor *in situ* (9b).

(9) a. [$_{CP}$ *wh* + NP [C°[$_{TP}$ ~~*wh* + NP~~ [V [$_{VP}$ ~~*wh* + NP~~ [~~V~~ O]]]]]]
b. [$_{CP}$ *wh* [C°[$_{TP}$ ~~*wh*~~ [V [$_{VP}$ ~~*wh*~~ + NP [~~V~~ O]]]]]]

2.3 The subject/object asymmetry: from data to theory

As anticipated in §1, subject and object *wh*-questions featuring movement of the *wh*-phrase do not stand on an equal footing when it comes to comprehension and production both in children and adults, in typical and atypical language acquisition, with the needle of the scale pointing towards subject *wh*-questions posing a minor challenge than object *wh*-questions. The peculiar and constant interest of the literature toward this syntactic construction is due to its complexity requiring knowledge of movement operations, capacity to reconstruct the moved elements, as well as processing of syntactic dependencies. Different theoretical proposals have been advanced trying to unveil the mechanisms underlying

the observed asymmetry, but the picture is not clear yet and the debate is still open.

A first approach to the subject/object asymmetry pivots on the role played by the unmarked word order and its subversion (Diessel & Tomasello 2005). In languages featuring the SVO order and leftward *wh*-movement, movement of the subject *wh*-phrase maintains the correct word order, while movement of the object *wh*-phrase yields a non-canonical configuration. Object *wh*-questions, but not subject *wh*-questions, would induce the parsers into errors when assigning thematic roles to constituents occupying a non-canonical surface word order obtained through *wh*-movement, leading them to garden path effects.

Another way to interpret the asymmetry is by positing that the core of the difficulty lies in the length of the A-bar chain: the longer the distance covered by the *wh*-operator and its gap in the base position corresponding to its interpretation, the more challenging its reconstruction (see The Minimal Chain Principle: De Vincenzi 1991; the Syntactic Distance Hypothesis discussed in O'Grady 1997: 135-138). As (10) shows, subject *wh*-questions display a shorter A-bar chain than object *wh*-questions, hence they require less processing effort and working memory capacity.

(10) a. Who <who> hugs the child?
b. Who does the child hug <who>?

A different approach, which can be advocated to make sense of the subject/object asymmetry, focuses on the hierarchical structure: the smaller the set of terminal and nonterminal nodes dominated by the filler in the filler-gap dependency, the easier the identification and interpretation of the gap (Hawkins 1999). According to this approach, subjects are more readily available than objects, as the latter are more embedded in the structure.

An explanation pivoting on hierarchical dependencies is offered in terms of intervention effects (cf. Friedmann, Belletti & Rizzi 2009's featural Relativized Minimality approach): the dependency between two elements cannot take place when a candidate for the same local relation intervenes between them yielding a Relativized Minimality violation (Rizzi 1990).

In object *wh*-questions, as exemplified in (11a), the DP subject (the child) hierarchically intervenes in the dependency relation between the moved *wh*-phrase who and its gap. Subject *wh*-questions, of the type in (11b), on the other hand, do not yield intervention effects, as nothing intervenes between the *wh*-phrase and the gap position.

(11) a. Who does the child hug <who>?
b. Who <who> pushes the child?

The more similar the features shared between the intervener and the two elements, the stronger the intervention effects. In the case of a nominal restrictor for the *wh*-phrase, the NP intervener and the *wh*-phrase (composed of which and a NP) are more similar in terms of shared features, thus stronger intervention effects are expected.

(12) a. Who object questions:
Wh Q.... D NP.... <Wh> ok
Who the boy hugged _____

b. Which object questions:
Wh NP Q D NP <Wh NP> *
Which monkey the boy hugged _____
(Friedmann, Belletti & Rizzi 2009: 79)

In (12a) the subject intervener has a lexical restrictor, but not the target *wh*-phrase, thus they are less similar than in (12b), where both the subject intervener and the target *wh*-phrase contain a lexical NP.

Such expectations are met in the works by Friedmann, Belletti & Rizzi (2009) who find that Hebrew-speaking children aged 3;7 to 4;10 scored significantly lower in the comprehension of object which questions (58%), than in that of subject which-questions (78%) but found no difference in their comprehension of subject and object who-questions (around 80% correct responses). Similar results are found in Avrutin (2000) for English-speaking children aged 3;5 to 5;2 and in Hickok & Avrutin (1996) for individuals with agrammatic aphasia. In all these studies, participants comprehended object which-questions less than subject which-questions, whereas such an asymmetry is not found for who-questions.

We shall now turn to sign languages as a test-bed to verify the solidity of the theoretical proposals advanced to account for the subject/object asymmetry observed in spoken languages.

3 The other side of the moon: sign languages

3.1 A cross-linguistic description of *wh*-questions

As in spoken languages, a core feature of *wh*-questions in sign languages is the presence of *wh*-signs: some sign languages have only one *wh*-sign

with a general interrogative meaning, which can be combined with non-interrogative signs such as TIME or FACE to convey specific meaning (for example, in Indo-Pakistani Sign Language – IPSL, the combination PLACE + INTERROGATIVE expresses the meaning 'where', cf. Aboh, Pfau & Zeshan 2005), while others display an extensive paradigm of *wh*-signs (e.g., LIS, American Sign Language – ASL) (Quer et al. 2017). In addition to having *wh*-signs with specific meanings, e.g., WHERE in (13), LIS also displays a general *wh*-sign, $Q_{\text{ARTICHOKE}}$, which can be used alone to convey different meanings (14). The syntactic context and the associated mouthing provide clues that help signers understand the meaning of this sign (Branchini et al. 2013).

(13) BOY SOCCER PLAY $\overline{\textbf{WHERE}}^{\text{wh}}$
'Where does the boy play soccer?' (LIS, Branchini et al. 2013: 163)

(14) POSS-IX_2 CAR BROKEN $\mathbf{Q_{ARTICHOKE}}$
'Where is/was your car broken??' (LIS, Branchini et al. 2013: 180)

Wh-questions are also obligatorily marked by non-manual markers. According to Quer et al. (2017), a shared non-manual marker is furrowed eyebrows. Cross-linguistically, three options have been observed for the distribution of the *wh*-sign: the *wh*-sign may remain *in situ* (15), it may appear in sentence-initial position (16), or in sentence-final position (17).

(15) $\overline{\text{TEACHER LIPREAD } \textbf{WHO} \text{ YESTERDAY}}^{\text{wh}}$
'Who did the teacher lipread yesterday?'
(ASL, Neidle et al., 2000: 111)

(16) $\overline{\textbf{HOW}\ {}_1\text{CONTACT}_3}^{\text{wh}}$
'How do I contact him?'
(Quebec Sign Language – LSQ, Dubuisson, Miller & Pinsonneault, 1994: 100)

(17) $\overline{\text{HOUSE BUY } \textbf{WHO}}^{\text{wh}}$
'Who bought a house?' (LIS, Cecchetto, Geraci & Zucchi 2009: 282)

Note that within a single sign language, different sign orders may be attested. In LIS, the *wh*-phrase generally occupies the right periphery of the sentence (17), although other options are also available: it can appear *in situ* when its content is contextually salient (18), or it can be doubled, appearing both at the beginning and end of the sentence, a possibility only allowed by existential presupposition (19).

(18) GIANNI $\overline{\textbf{WHO}\ \text{KISS}}^{\text{wh}}$
'Who of them did Gianni kiss?' (LIS, Branchini et al. 2013: 45)

(19) $\overline{\textbf{WHAT}\ \text{IX}_2\text{SEE DONE}\ \textbf{WHAT}}^{\text{wh}}$
'What is it that you saw?' (LIS, Branchini et al. 2013: 175)

Overall, contrary to what has been observed in spoken languages (§2.1), the sentence-final position appears to be very commonly used in sign languages.

In some cases, the *wh*-phrase may host a nominal restrictor, which may be subject to pied-piping or stranding. These two options are both available in LIS, as illustrated below: in (20) the *wh*-sign WHICH and the lexical restrictor BOOK occupy the right periphery of the sentence, while in (21) the lexical restrictor BOY remains *in situ* and the *wh*-sign WHICH is dislocated in sentence-final position.

(20) PAOLO STEAL $\overline{\textbf{BOOK}_\textbf{J}\ \textbf{WHICH}_\textbf{J}}^{\text{wh}}$
'Which book did Paolo steal?'
(LIS, Cecchetto, Geraci & Zucchi 2009: 285)

(21) $\textbf{BOY}_\textbf{J}$ BOOK STEAL $\overline{\textbf{WHICH}_\textbf{J}}^{\text{wh}}$
'Which boy stole the book?'
(LIS, Cecchetto, Geraci & Zucchi 2009: 285)

3.2 Theoretical approaches

Over the past thirty years, there has been a considerable debate among linguists regarding the syntactic analysis of *wh*-questions in sign languages. In particular, two competing views have arisen in the literature: the leftward analysis (Lillo-Martin 1990; Petronio 1993; Petronio & Lillo-Martin 1997) and the rightward analysis (Aarons et al. 1992; Neidle et al. 1997; Neidle et al. 2000; Cecchetto, Geraci & Zucchi 2009). For illustrative purposes, both analyses are accompanied by abstract syntactic derivations inspired by Pfau & Zeshan (2003), as well as examples from ASL (Petronio & Lillo-Martin 1997; Neidle et al. 1997).

According to the leftward analysis, Spec,CP is situated in the left periphery, functioning as the landing site for the *wh*-sign or a null *wh*-element (*e*) and *wh*-movement is universally leftward, despite superficial differences in ordering patterns between the two modalities. Cases where

the *wh*-sign appears in sentence-final position are not accounted for as instances of right dislocation, but rather as a base-generated double occupying the head of CP. Below we provide the abstract derivation of a subject *wh*-question with a sentence-final *wh*-sign (22a) and a doubled *wh*-sign (23b) according to the leftward analysis.

(22) a. BUY CAR $\overset{\text{wh}}{\textbf{WHO}}$
'Who bought the car?' (ASL, Petronio & Lillo-Martin 1997: 18)

b. [$_{\text{CP}}$ *e* [$_{\text{C'}}$ [$_{\text{TP}}$ ~~*wh*~~ [V [$_{\text{VP}}$ ~~*wh*~~ [~~V~~ O]]]] $_{\text{C°}}$ *wh-base generated double*]]

(23) a. **WHO** BUY C-A-R $\overset{\text{wh}}{\textbf{WHO}}$
'Who bought the car?' (ASL, Petronio & Lillo-Martin 1997: 15)

b. [$_{\text{CP}}$ *wh* [$_{\text{C'}}$ [$_{\text{TP}}$ ~~*wh*~~ [V [$_{\text{VP}}$ ~~*wh*~~ [~~V~~ O]]]]$_{\text{C°}}$ *wh-base generated double*]]

On the other hand, the proponents of the rightward analysis assume that, in sign languages, Spec,CP is on the right and that the *wh*-sign moves rightward to reach that position. This analysis is able to account for the *wh*-sign *in situ* and straightforwardly captures the *wh*-sign in sentence-final position as an instance of right dislocation (24a).

(24) a. $\overset{\text{wh}}{\text{HATE JOHN } \textbf{WHO}}$
'Who hates John?' (ASL, Neidle et al. 2000: 128)

b. [$_{\text{CP}}$ [$_{\text{TP}}$ ~~*wh*~~ [V [$_{\text{VP}}$ ~~*wh*~~ [~~V~~ O]]]] *wh*]

When the *wh*-sign is found at the beginning of the sentence, it is treated as a base-generated topic preceding the question CP, as illustrated in the object *wh*- question in (25a) and its abstract derivation according to the rightward analysis (25b).

(25) a. $\overline{\text{WHAT JOHN BUY WHAT}}^{\text{wh}}$
'What, what did John buy?' (ASL, Neidle et al. 2000: 143)

b. [$_{\text{xp}}$ *wh-base generated topic* $_{\text{CP}}$ [$_{\text{TP}}$ S [V [$_{\text{VP}}$ ~~S~~ [~~V~~ *wh*]]]] *wh*]

The rightward approach highlights a key difference between spoken and sign languages because *wh*-movement is assumed to be leftward in the former and rightward in the latter. An attempt to reduce the distance between the two modalities is represented by the remnant movement analysis (see discussion in Cecchetto, Geraci & Zucchi 2009; Aboh & Pfau 2011). This approach is compatible with the antisymmetric framework and assumes that *wh*-movement is universally leftward. Under this proposal, the sentence-final position of *wh*-phrases in sign languages derives from two leftward movements: first, the *wh*-phrase moves to Spec,CP, then the remnant, i.e., the constituent out of which the *wh*-phrase has moved, is moved to its left (26).

(26) a. HOUSE BUY $\overline{\text{WHO}}^{\text{wh}}$
'Who bought a house?'
(LIS, Cecchetto, Geraci & Zucchi 2009: 282)

b. [$_{\text{XP}}$ [$_{\text{TP}}$ ~~wh~~ [V [$_{\text{VP}}$ ~~*wh*~~ [~~V~~ O]]] [$_{\text{CP}}$ *wh* [~~$_{\text{TP}}$ *wh* [V [$_{\text{VP}}$ *wh* [V O]]]~~]]]

In this study, we assume the rightward approach for LIS *wh*-questions, as suggested by Cecchetto, Geraci & Zucchi (2009).

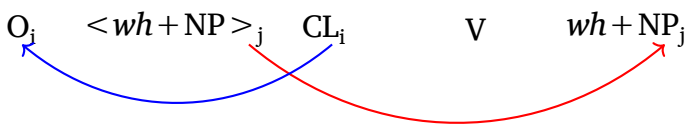
3.3 The subject/object asymmetry: from data to theory

The subject/object asymmetry in the processing of *wh*-questions in sign languages has only recently received attention within the scientific community.

Cecchetto et al. (2022) investigate the impact of age of exposure on the comprehension of LIS WHICH questions displaying movement of the *wh*-sign and its lexical restrictor to the right periphery of the sentence through a sentence-to-picture matching task. Unexpectedly, their study reveals that accuracy in subject interrogatives is lower than in object interrogatives across all groups of participants (adult deaf native, early, and late signers). The result is surprising if compared with similar studies conducted on spoken languages (§2.3). After discussing several factors that may determine the observed pattern, the authors suggest that the degradation of subject interrogatives could be influenced by the particular configuration of the stimuli. In the experiment, only subject *wh*-questions include a whole entity classifier functioning as the internal

argument and triggering spatial agreement with the verb. This classifier is coreferential with the object, which is topicalised as it is fronted at the beginning of the sentence and is accompanied by raised eyebrows. The authors argue that the subject *wh*-questions included in their experiment involve two kinds of dependencies (topicalisation and *wh*-movement), which crucially develop in opposite directions (27). This particular configuration is claimed to be a source of structural complexity for the subject *wh*-questions used in the experiment.

(27)



(LIS, Cecchetto et al. 2022: 24)

A second study addressing the issue is Hauser, Aristodemo & Donati (2023) on the comprehension of WHO and WHICH questions in French Sign Language – LSF, a SVO sign language in which the *in situ* configuration is the preferred option. The data come from a sentence-to-picture matching task administered to adult deaf native, early, and late LSF signers. All the experimental items follow the SVO order. The results from the quantitative analysis reveal a subject advantage, thus showing the same asymmetry observed in spoken languages. The authors argue that the subject advantage cannot be attributed to explanations based on linear distance (since no *wh*-movement occurs) nor on canonical-word-order effects (as both subject and object *wh*-questions follow the canonical word order observed in declaratives). Instead, the authors claim that the obtained results support a covert-movement analysis. Like other *wh-in-situ* languages such as Bengali, LSF shows no evidence for the existence of a scope marker and unselective binding.

4 The experimental study

4.1 Research questions and predictions

As previously introduced, the present study investigates the comprehension of a subtype of LIS *wh*-questions featuring the stranding of the nominal restrictor (see example (3), repeated here as (28)) in three populations of adult LIS signers (hearing CODAs, deaf natives, and deaf non-natives) in a sentence-to-picture matching task.

(28) CHILD CANDY BUY WHICH
'Which child buys the candy??'
'Which candy does the child buy?'

Within the first phase of the experiment, we aimed at verifying whether signers opt for a subject or object interpretation of the lexical restrictor of the *wh*-sign in sentences like (28), in the absence of linguistic strategies able to avoid ambiguity. We analysed the responses of the three groups of signers at the light of the theories advanced to explain the subject/object asymmetry found in *wh*-questions in spoken languages and in the sign languages for which an investigation has been carried out. Since LIS is a SOV language featuring *wh*-movement to the right, the theoretical proposals advanced to account for the subject/object asymmetry in spoken languages with SVO order and leftward *wh*-movement yield very different predictions. Proposals capitalising on word order predict that no asymmetry should be detected in sentences like (28), where no change in word order surfaces regardless of the subject or object interpretation. Proposals pivoting on the linear distance between the gap and the moved element predict LIS object *wh*-questions to be easier than subject *wh*-questions, as the linear distance between the object gap and the moved *wh*-element is shorter in the former. Proposals relying on the structural distance between the gap and the moved element predict a preference for subject over object *wh*-questions, regardless of the surface word order displayed and of the direction of *wh*-movement. Proposals appealing to hierarchical intervention similarly expect LIS object *wh*-questions to involve the intervention of the subject in the dependency relation between the object and its gap, therefore subject *wh*-questions should be easier than object questions. In the second part of the experiment, we administered a battery of *wh*-questions displaying some strategies able to resolve the ambiguity of sentences like (28) above, as illustrated in §4.3 below. The aim of this second phase of the experiment was to identify which strategy is most effective in solving the ambiguity and to verify whether age of acquisition plays a role in the preference granted to the linguistic strategies proposed.

4.2 Participants

Forty-six participants were involved in our experiment representing the northern, central, and southern regions of Italy. They were divided into three groups: the first group was composed of 17 adult hearing CODAs, the second one entailed 14 adult deaf native LIS signers, and the third

group was composed of 15 adult deaf non-native LIS signers.[5] Participants were recruited through personal contact or social media. Two participants (one from the non-natives' group, and one from the CODAs' group) were later excluded from the analysis: one due to a poor performance in the task administered and the other due to lack of frequent use of LIS. The 17 hearing CODA participants were aged between 27 and 58 years (M = 38.82; SD = 9.46), all of whom had been exposed to LIS in a familiar context from birth. All participants use LIS on a daily basis. 14 of them hold roles within the National Deaf Association (hereafter ENS) as LIS instructors, LIS interpreters, or communication and autonomy assistants for the Deaf.[6] The 14 deaf native signers were aged between 22 and 66 years (M = 44.79; SD = 12.12). They all had prelingual deafness and were born and raised in Italy. All deaf native signers were exposed to LIS from birth within their families. As for their education, 5 received a bimodal bilingual education, 4 were supported by a communication assistant or interpreter, and 5 received an oralist education.[7] They all use LIS daily for communicating. When it comes to their occupation, 10 signers held positions within ENS, including roles in the Executive Council or positions as LIS instructors, LIS interpreters, and LIS performers. Finally, regarding family background, all participants live in close contact with other Deaf signing relatives. The last group was composed of 15 deaf non-native adults aged between 22 and 64 years (M = 44.92; SD = 10.46). All participants had prelingual deafness and were born and raised in Italy, except for two who were born in Russia and Algeria. In terms of age of exposure, 6 were introduced to LIS between the ages of 2 and 3 in an institutional setting or at kindergarten, 3 were exposed to LIS between 4 and 8 years old, and the remaining 7 were exposed to LIS later in life, after the age of 18. With regard to their education, 3

5. The term "native signers" refers to deaf individuals born in Deaf signing families, who are therefore exposed to a sign language from birth through their parents (Branchini & Mantovan 2022). The term "non-native signers" is used to refer to deaf individuals exposed to sign language after the age of 3 due to personal or educational reasons (Mayberry 1993). Our dataset included 4 signers exposed to LIS from 1 to 3 years of age which are usually considered 'early signers'. We decided to include the 4 participants in the non-native group because, on a visual inspection, their performance more closely resembled that of the non-native signers' group rather than that of the native signers' group. The CODA group includes 1 BODA (Brother of Deaf Adults) exposed to LIS from birth.

6. As is common practice, we use the capital letter for the term 'deaf' when it does not only refer to the physical condition of the individuals, but also to their belonging to a cultural community.

7. As discussed by Moores (2010), an oralist education consists in adopting written and spoken language, excluding sign language. Children are trained to use their residual hearing, often with the use of hearing devices like hearing aids or cochlear implants, to discriminate speech sounds and to understand language through lip-reading.

received a bilingual education, 10 received an oralist education, and 2 were supported by a communication assistant or interpreter.

4.3 Experimental design

Our sentence-to-picture matching task was set up on Gorilla Experiment Builder software (Anwyl-Irvine et al. 2021).[8] The task consisted of 32 experimental items preceded by 3 familiarisation stimuli all presented in the form of LIS videos featuring WH + NP interrogative sentences containing the interrogative sign WHICH and displaying the unmarked word order SOV.[9] Additionally, 8 filler sentences have been incorporated. Fillers did not present particular syntactic difficulties, as they contained only one noun phrase and were unambiguous (e.g., SOCK GREEN WHICH 'Which is the green sock?'). These sentences were introduced in the task to divert participants' attention from its actual purpose, to motivate them by adding simpler structures during the task, and to prevent the task from being carried out in a rote manner. The task was composed of 4 categories of *which*-questions:

- 8 *wh*-questions featuring the stranding of the nominal restrictor and ambiguous between a subject and object interpretation. In these sentences, ambiguity does not lie in the thematic roles of the verb arguments, rather, it is due to the interpretation of the lexical restrictor (the subject or object NP) of the *wh*-sign WHICH. In the presence of a match in animacy feature of the two NPs, the unmarked SOV word order (e.g., CHILD WOMAN GREAT WHICH 'Which child greets the woman?' or 'Which woman does the child greet?') guided the participants in their interpretation of the thematic roles of the verbal arguments;
- 7 unambiguous *wh*-questions featuring pied-piping (e.g., NAPKIN TAKE WOMAN WHICH 'Which woman takes the napkin?');[10]
- 8 unambiguous *wh*-questions featuring spatial agreement between the *wh*-sign WHICH and its lexical restrictor (e.g., WOMAN CANDY$_{I}$ BUY WHICH$_{I}$ 'Which candy does the woman buy?');
- 8 unambiguous *wh*-questions featuring a pointing sign spatially agreeing with the lexical restrictor of the *wh*-sign which and produced before it (e.g., *child pencil$_i$ borrow ix$_i$ which* 'Which pencil

8. https://www.gorilla.sc/

9. 6 out of 32 stimuli presented the non-canonical OSV word order. The introduction of these items was meant to verify whether a change in linear order would influence the participants' preference for the lexical restrictor of the wh-sign (the subject or object NP). If this was the case – that is, if participants' accuracy was higher in subject rather than object questions in these items – we could explain the result by appealing to linear accounts, such as the Minimal Chain Principle. This, however, was not the case.

10. One sentence was erased from the initial dataset due to an error in coding.

does the child borrow?').

The choice of the strategies proposed to participants to guide their interpretation in otherwise potentially ambiguous sentences comes from discussions with our native informants who also helped us record the video stimuli. The inclusion of different disambiguating strategies allows us to test theoretical predictions such as the one advanced by the featural Relativized Minimality approach according to which object *wh*-questions featuring Pied-piping of the lexical restrictor would induce more intervention effects, therefore a lower accuracy rate than *wh*-questions featuring the stranding of the nominal restrictor, due to the closer similarity in syntactic features between the intervening subject and the object in its dependency with the gap position. For each category, except for *wh*-questions featuring Pied-piping, the sentences were evenly divided between those whose subject and object NP matched in animacy feature and those that displayed a mismatch in animacy features.[11] In case of mismatch in animacy features, the object was always [-animate], while, in case of matching, in unambiguous sentences, the two NPs were either both [+animate] or both [-animate], while in ambiguous ones they were invariably [+animate]. Within each category, a different number of agreeing and non-agreeing verbs have been employed (see Table 1 for a more detailed description of the types of verbs included in the stimuli).[12]

11. Within the Pied-piping strategy, we had 5 sentences with a mismatch in animacy feature of the two NPs and 2 sentences with matching NPs. There was no specific reason for this difference, it was rather an accidental fact.

12. The stimuli containing two [-animate] referents were characterised by verbs like: produce, sell, organize and send.

Sentence type	**Agreeing + Reversible**	**Agreeing + Non-reversible**	**Non-agreeing + Reversible**	**Non-agreeing + Non-reversible**
Ambiguous	1	0	3	4
Pied-piping	1	5	0	1
Space agrmt.	2	3	1	2
Pointing sign	2	4	1	1
Total	6	12	5	8
Example	QUESTION, SELECT, CRITICISE, HATE, MOVE, GREET	BUY (x2), SELL (x2), PAINT, TAKE, WASH, PET, LEND, ORGANISE, ATTEND	ACCOMPANY, (citation form), FIGHT, CALL (citation form), LOOK_FOR, WAIT	PRODUCE, EAT, LIKE, SEND (citation form), WATER, TAKE (citation form), DRINK, WIN

Table 1: Number of agreeing and non-agreeing verbs, and reversible and non-reversible verbs per sentence type.

Finally, for each strategy, sentences displayed an equal number of correct subject and object questions. Table 2 shows the distribution of stimuli by sentence type, condition, animacy feature, and subject vs. object interpretation.

Sentence type	Condition	Animacy feature	Interpretation Subj - Obj	N items	Example sentence
Ambiguous	Match	Animate–Animate	Subject/Object	4	JOURNALIST CAMERA-MAN WAIT WHICH
Ambiguous	Mismatch	Animate–Inanimate	Subject/Object	3	ELECTRICIAN CABLE TAKE WHICH
Ambiguous	Mismatch	Inanimate–Animate	Subject/Object	1	PLANT MAN WATER WHICH
Pied-piping	Match	Animate–Animate	Subject	2	WAITER CRITICIZE CHEF WHICH
Pied-piping	Match	Inanimate–Inanimate	Subject	1	CAKE SELL SHOP INSIDE WHICH
Pied-piping	Mismatch	Animate–Inanimate	Object	2	CHILD PET DOG WHICH

Sentence type	Condition	Animacy feature	Interpretation Subj - Obj	N items	Example sentence (cont.)
Pied-piping	Mismatch	Inanimate–Animate	Subject	2	BAG BUY WOMAN WHICH
Space agrmt.	Match	Animate–Animate	Subject	2	TEACHER$_i$ STUDENT ACCOMPANY WHICH$_i$
			Object	1	WITNESS JUDGE$_i$ QUESTION WHICH$_i$
Space agrmt.	Match	Inanimate–Inanimate	Subject	1	GAME FACTORY$_i$ INSIDE PRODUCE WHICH$_i$
Space agrmt.	Mismatch	Animate–Inanimate	Object	2	WOMAN CANDY$_i$ BUY WHICH$_i$
Space agrmt.	Mismatch	Inanimate–Animate	Object	2	SANDWITCH$_i$ CHILD EAT WHICH$_i$
Pointing sign	Match	Animate–Animate	Subject	1	DOG$_i$ CAT FIGHT IX$_i$ WHICH
			Object	1	WOMAN COLLEAGUE$_i$ HATE IX$_i$ WHICH
Pointing sign	Match	Inanimate–Inanimate	Subject	1	WEBSITE$_i$ MESSAGE SEND IX$_i$ WHICH
			Object	1	SCHOOL PARTY$_i$ ORGANIZE IX$_i$ WHICH
Pointing sign	Mismatch	Animate–Inanimate	Subject	2	THIEF$_i$ GUN TAKE IX$_i$ WHICH
			Object	1	CHILD PENCIL$_i$ LEND IX$_i$ WHICH

Sentence type	Condition	Animacy feature	Interpretation Subj - Obj	N items	Example sentence (cont.)
Pointing sign	Mismatch	Inanimate–Animate	Object	1	UNIVERSITY$_i$ BOY ATTEND IX$_i$ WHICH

Table 2: Distribution of stimuli by sentence type, condition, animacy feature, and subject vs. object interpretation.

Non-manual markers for content *wh*-questions have been spontaneously produced in the stimuli, while the presence of non-manual markers of (subject and object) agreement are present only in one out of eight ambiguous *wh*-questions, as we wanted to provide no overt clue, other than word order, to the subject/object interpretation of the sentences, and were spontaneously produced in unambiguous *wh*-questions. All parts of the experiment were administered online. To carry out the task, we asked each participant to carefully watch a LIS video playing the *wh*-sentences on a computer screen along with two images simultaneously appearing at the bottom of the screen. Afterwards, participants were asked to select the image corresponding to the NP they believed to be the lexical restrictor of the *wh*-sign WHICH (Figure 1[13]).

To select their response, participants had to click on the image. Once they had done so, they were immediately directed to the next item. The transition from one item to another was indicated by a fixation cross, allowing participants to maintain their focus. The LIS videos could be played an unlimited number of times. The decision not to limit the number of plays was motivated by the fact that we were not interested in recording reaction times, we rather wanted the participants to reflect on the sentence before making their judgement. To prevent excessive fatigue, the stimuli were divided into four distinct blocks, each separated by a break. In this way, after completing each section, participants had the opportunity to take some rest and resume the task at their own convenience. In the task, the order of the items was randomised. The test was considered concluded only when each participant had undergone all four blocks. Before each experimental session, we provided participants with a sociolinguistic questionnaire in digital format, where we offered information on the scope and procedures of the study, and collected data regarding personal information of the participants, as well as their linguistic experience and familial linguistic background. Our study and the consent forms received approval by the Research Ethics Committee at Ca' Foscari on 05.02.2020, protocol n. 1/2020. All participants in

13. In Figure 1, 'QUALE' corresponds to the *wh*-sign which.

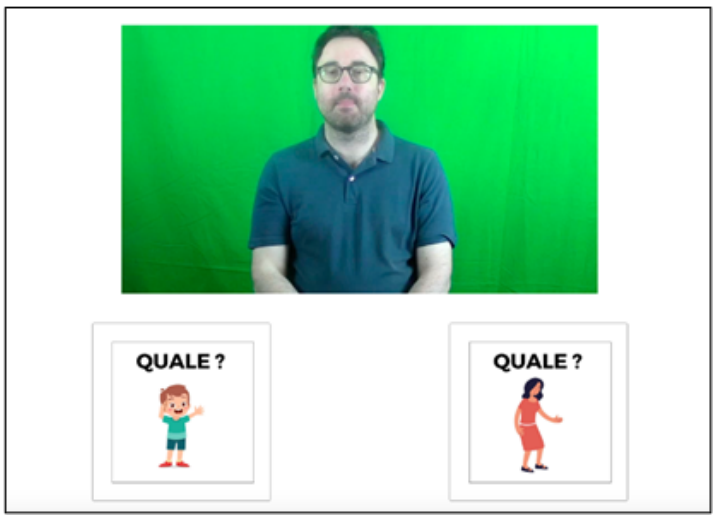


Figure 1: Experimental stimuli for the sentence CHILD WOMAN GREET WHICH.

the experiment provided written informed consent for the processing of personal data, including information related to their health status (i.e., deafness), in compliance with the Declaration of Helsinki (2001), and according to the standards established by the BemboLab of the Department of Linguistic and Comparative Cultural Studies at Ca' Foscari University of Venice. After signing the informed consent form, participants were sent a link to access the Gorilla software and complete the task. To ensure both privacy and anonymity, access to the platform was secured by the use of a personalised alphanumeric identification code. All raw data and experimental materials are openly available on the Open Science Framework under a Creative Commons license: https://osf.io/j3xvf/.

4.4 Data Analysis

Separate analyses were performed to assess participants' performance in responding to unambiguous vs. ambiguous sentences. As for the unambiguous sentences, participants' accuracy served as the dependent variable in two different Repeated Measures Analyses of Variance (rmANOVAs). The first rmANOVA was conducted to assess the effect of the match in animacy features of the two NPs (henceforth "condition": Match vs. Mismatch), while the second one was conducted to assess the effect of the animacy feature of the NP representing the correct answer (+Animate vs. -Animate) and of the grammatical function of the target element (Subject vs. Object). Both rmANOVAs also included the participant group (CODA vs. native vs. non-native signer) as a between-subject factor and the strategy (Spatial agreement vs. Pied-piping vs. Pointing sign) as a within-subject factor to assess their overall effect or

their possible role in moderating the effects of the aforementioned variables. As for the ambiguous sentences, the proportions of subjects chosen by our participants were analysed as a function of the participant group (CODA vs. native vs. non-native signer) and of the condition (Match vs. Mismatch). Post-hoc analyses, with Holm's correction, were performed to disentangle possible significant interactions between factors. All analyses were carried out using the "afex" (Singmann et al. 2023) and "emmeans" (Lenth, 2023) packages in the R computing environment (R Core Team, 2023).

4.5 Results

Overall, we collected 1,012 judgments for the unambiguous sentences and 368 for the ambiguous ones, for a total of 1,380 valid judgments.

4.5.1 Ambiguous sentences: perceived objecthood as a function of participant group and condition

The rmANOVA revealed a significant main effect of condition $F(1, 41) = 34.21$, $p < .001$, $\eta_p^2 = .455$, shown in Table 3, while the main effect of the participant group (shown in the bottom row column marginals of Table 4) and its interaction with condition failed to reach statistical significance. Post-hoc analysis confirms that the average 27 percentage points of difference in the proportions of objects chosen in the matching condition with respect to those selected in the non-matching condition is statistically significant $t(41) = 5.849$, $p < .001$ (see Table 3). Although the interaction between condition and the participant groups is not significant, there seems to be an interesting numerical difference between the three groups in the matching condition (see Table 4): non-native signers showed a smaller proportion of chosen objects compared to both native signers and CODAs. Follow-up analyses contrasting the expected marginal means inferred from this model against chance level showed a statistically significant preference for choosing the object over the subject for all participant groups in the non-matching condition $p_S < .001$, and for only CODAs in the matching condition $p = .011$, whereas the behaviour of the other two groups in the matching condition is not different from chance-level.

4.5.2 Unambiguous sentences: accuracy as a function of condition, participants' group and strategy

The rmANOVA revealed a significant effect only of condition $F_1(1, 41) = 28.54$, $p < .001$, $\eta_p^2 = .41$ and of its interaction with strategy

	Condition		
	Match	Mismatch	Full Sample
Grammatical function	M (SD)	M (SD)	M (SD)
Subject	41.48% (27.99%)	14.77% (21.1%)	28.12% (19.28%)
Object	58.53% (27.99%)	85.23% (21.1%)	71.87% (19.28%)

Table 3: Proportion of selected grammatical function (Subject/Object) as a function of condition (match/mismatch). The last column shows the overall proportion of selected grammatical function.

	Group		
	CODA	Native	Non-native
Condition	M (SD)	M (SD)	M (SD)
Match	67.65% (26.17%)	58.93% (28.77%)	46.15% (26.7%)
Mismatch	88.24% (20%)	82.14% (15.28%)	84.62% (28.02%)
Full Sample	77.94% (20%)	70.54% (17.41%)	65.38% (19.2%)

Table 4: Proportion of selected NP-objects as a function of condition and participant group. The last row shows the overall proportion of selected NP-objects as a function of the participant group alone.

$F_1(1.82, 74.54) = 4.49$, $p = .017$, $\eta_p^2 = .099$. Post-hoc analyses showed that the 12 percentage points higher accuracy in the mismatch condition than in the match condition (see the rightmost column of Table 5) is statistically significant $t(41) = -5.342$, $p < .001$. As for the two-way interaction, shown in Table 5, the differences between the match and the mismatch condition reached statistical significance both in the Pied-piping $t(41) = -2.776$, $p < .001$ and in the Spatial agreement $t(41) = -4.146$, $p < .001$ sentences, while the same contrast in the Pointing sign sentences looks negligible $t(41) = -0.508$, $p = .614$.

Statistical significance was not achieved for any of the other main effects and interactions. There are however a few results worth discussing. First, the bottom row of Table 6 shows some differences between participant groups: non-native signers tend to be less accurate than native signers and CODAs. Another meaningful comparison is that between the different strategies, similar accuracy scores were recorded in all of them (see the rightmost column in Table 7). The interaction between these two variables (shown in Table 6) reveals an interesting pattern: while all three participant groups performed similarly in sentences with Spatial agreement, non-native signers were less accurate than the other two groups both in sentences involving the Pied-piping and the Pointing sign strategy.

	Group		
	CODA	Native	Non-native
Condition			
	M (SD)	M (SD)	M (SD)
Match	67.65% (26.17%)	58.93% (28.77%)	46.15% (26.7%)
Mismatch	88.24% (20%)	82.14% (15.28%)	84.62% (28.02%)
Full Sample	77.94% (20%)	70.54% (17.41%)	65.38% (19.2%)

Table 5: Participant-wise accuracy in the unambiguous sentences as a function of condition and strategy. The rightmost column shows accuracy in the different conditions independently of the strategy.

	Group		
	CODA	Native	Non-native
Strategy			
	M (SD)	M (SD)	M (SD)
Spatial agreement	76.47% (14.58%)	77.68% (13.14%)	77.88% (19.87%)
Pied-piping	81.51% (20.05%)	80.61% (9.04%)	73.63% (20.9%)
Pointing sign	80.15% (20.76%)	82.14% (19.44%)	69.23% (20.8%)
Full Sample	79.28% (13%)	80.12% (9.45%)	73.58% (17.07%)

Table 6: Participant-wise accuracy in the unambiguous sentences as a function of participant group and strategy. The bottom row shows overall accuracy for each participant group, averaged across strategies.

	Grammatical function		
	Subject	Object	Full Sample
Strategy			
	M (SD)	M (SD)	M (SD)
Spatial agreement	65.12% (28.13%)	84.26% (15.89%)	77.27% (15.55%)
Pied-piping	77.52% (28.84%)	79.77% (19.35%)	78.9% (17.56%)
Pointing sign	69.19% (31.2%)	86.36% (21.87%)	77.56% (20.64%)

Table 7: Participant-wise accuracy in the unambiguous sentences as a function of grammatical function and strategy. The rightmost column displays accuracy in the different strategies independently of the grammatical function.

Another interesting result emerges when comparing the subject/object accuracy across the different disambiguating strategies: while the Spatial agreement and Pointing sign strategies show an asymmetry with object questions eliciting significantly higher accurate responses, the subject/object asymmetry disappears in the Pied-piping strategy. Finally, even if statistical significance was not achieved for the interaction between participant group, condition, and strategy, here shown in Table 8, CODAs and native signers seem to be more sensitive to the match/mismatch opposition than non-native signers: CODAs take advantage of the mismatch condition in the Spatial agreement sentences, while natives both in the Spatial agreement and Pied-piping sentences.

Strategy	Group					
	CODA		Native		Non-native	
	Match M (SD)	Mismatch M (SD)	Match M (SD)	Mismatch M (SD)	Match M (SD)	Mismatch M (SD)
Spatial agreement	61.76% (26.69%)	91.18% (12.31%)	62.5% (29%)	92.86% (11.72%)	75% (27%)	80.77% (29.14%)
Pied-piping	78.43% (23.4%)	83.82% (21.54%)	66.66% (22.65%)	91.07% (18.62%)	69.23% (28.74%)	76.92% (23.85%)
Pointing sign	79.42% (23.78%)	80.88% (20.78%)	82.14% (20.64%)	82.14% (20.64%)	67.3% (25.79%)	71.15% (28.59%)

Table 8: Participant-wise accuracy in the unambiguous sentences as a function of participant group, condition, and strategy.

4.5.3 Unambiguous sentences: accuracy as a function of animacy, grammatical function, participant group, and strategy

The rANOVA revealed a significant effect of the grammatical function of the target element $F_1(1, 39) = 5.28$, $p = .027$, $\eta_p^2 = .119$, of the animacy of the target element $F_1(1, 39) = 10.30$, $p = .003$, $\eta_p^2 = .209$, as well as the two-way interactions between grammatical function and animacy $F_1(1, 39) = 6.47$, $p = .015$, $\eta_p^2 = .142$, between grammatical function and strategy $F_1(1.88, 73.35) = 9.62$, $p < .001$, $\eta_p^2 = .198$, and between animacy and strategy $F_1(2, 77.89) = 9.76$, $p < .001$, $\eta_p^2 = .2$. Post-hoc analyses showed that the 12 percentage points higher accuracy for object targets compared to subject targets shown in the rightmost column of Table 9 is statistically significant $t(39) = 3.262$, $p = .002$. Likewise, the 13 percentage points higher accuracy for non-animate targets compared to animate targets shown in the bottom rows of Table 9 is statistically significant $t(39) = -2.81$, $p = .008$.

	Animacy		
	+Animate	-Animate	Full Sample
Grammatical function			
	M (SD)	M (SD)	M (SD)
Subject	71.1% (26.59%)	69.7% (29.5%)	70.8% (22.46%)
Object	72.65% (20.04%)	88.15% (17.44%)	83.43% (14.6%)
Full Sample	70.23% (21.73%)	83.74% (14.58%)	

Table 9: Participant-wise accuracy in the unambiguous sentences as a function of grammatical function and animacy. The bottom row displays accuracy for the different animacy values independently of the grammatical function. The rightmost column shows overall accuracy for the different grammatical functions independently of animacy.

Moving to the statistically significant two-way interactions, the post-hoc analysis of the interaction between animacy of the target and grammatical function, shown in the body cells of Table 9, revealed a significant difference between non-animate object targets and all the other types of targets. Specifically, there was a significant difference against the animate object targets $t(39) = -4.306$, $p < .001$, the non-animate subject targets $t(39) = 3.633$, $p = .003$, and – less interestingly – the animate subject targets $t(39) = -4.169$, $p < .001$. The interaction between the grammatical function of the target and the strategy is shown above in Table 7. Post-hoc analysis revealed a significant difference between objects and subjects in sentences displaying a Pointing sign $t(39) = 3.585$, $p = .014$, and between objects in the Pointing sign strategy and subjects in Spatial agreement sentences $t(39) = 3.366$, $p = .024$.

Table 10 describes the interaction between the animacy of the target NP and the strategy. Post-hoc analysis revealed a significant difference between [+animate] NPs in sentences with the Pointing sign and Pied-piping $t(39) = 2.286$, $p = .028$, between [+animate] and [-animate] NPs in sentences with Pied-piping $t(39) = -3.105$, $p = .046$, between [-animate] NPs in Pied-piping and [+animate] NPs in Spatial agreement sentences $t(39) = -3.525$, $p = .016$, and between [+animate] and [-animate] NPs in Spatial agreement sentences $t(39) = -3.248$, $p = .033$.

	Strategy		
	Spatial agreement	Pied-piping	Pointing sign
Animacy			
	M (SD)	M (SD)	M (SD)
+Animate	63.63% (32%)	72.16 % (24.24%)	76.7% (26.63%)
-Animate	85.45% (15.17%)	87.88% (22.84%)	78.41% (24.47%)

Table 10: Participant-wise accuracy in the unambiguous sentences as a function of animacy and strategy.

Even if we did not find a significant effect of the interaction between participant group, grammatical function and strategy, it is worth noting how the pattern observed in Table 11 for CODAs and native speakers mirrors the overall tendency described in Table 7 above for ambiguous sentences. For these two participant groups, indeed, the Spatial agreement and Pointing sign strategies show an asymmetry with object questions eliciting significantly higher accurate responses, while the subject/object asymmetry disappears in the Pied-piping strategy. Non-native signers, on the other hand, show a clear advantage for object questions only in the Pied-Piping and Pointing Sign strategies.

Strategy	Group					
	CODA		Native		Non-native	
	Subject M (SD)	Object M (SD)	Subject M (SD)	Object M (SD)	Subject M (SD)	Object M (SD)
Spatial agreement	58.33% (28.54%)	86.32% (11.66%)	61.9% (28.81%)	87.14% (9.95%)	76.92% (25.04%)	78.46% (23.75%)
Pied-piping	81.25% (24.25%)	80.88% (22.59%)	83.33% (25.32%)	79.29% (15.42%)	66.66% (36%)	78.85% (20.02%)
Pointing sign	67.65% (31.58%)	92.65% (19.29%)	75% (32.27%)	91.07% (18.62%)	65.38% (34.67%)	73.08% (23.85%)

Table 11: Participant-wise accuracy in the unambiguous sentences as a function of participant group, grammatical function, and strategy.

4.6 Discussion

The aim of this section is to summarise and comment on the most interesting results coming out of the data analysis.

4.6.1 Ambiguous sentences

Let us first look at ambiguous sentences. Within this sentence type, the main result is a marked preference of participants for an object over a subject interpretation of the *wh*-sign's lexical restrictor. The result is confirmed across groups. If we look at this result against the predictions outlined in §4.1, we could *prima facie* say that the data support proposals accounting for the subject/object asymmetry pivoting on the linear distance between the gap and the moved element (due to the rightward movement of the *wh*-word in LIS), while discharging proposals capitalising on word order (both NPs are *in situ*), structural distance between the gap and the moved element and hierarchical intervention (both predicting a subject preference). If, however, we introduce a further variable in the analysis, that is, the match/mismatch condition in animate features between the two NPs carrying out the subject and object role in the sentence, we find that participants' choice is driven by animacy. While in the matching condition the choice is at chance between a subject and object interpretation of the *wh*-lexical restrictor, the preference for an object interpretation (carrying the [-animate] feature) significantly raises in the mismatch condition (Table 3). This result is confirmed by the analysis carried out across groups, with all groups behaving evenly in the mismatch condition, and only CODAs displaying a higher preference for an object interpretation in the matching condition too, whereas native and non-native signers are at chance level (Table 4). A way to explain this result is to assume that the *wh*-sign WHICH carries a specified inherent [-animate] feature, which is more commonly associated with objects rather than subjects.

4.6.2 Unambiguous sentences

Let us now turn to the accuracy in unambiguous *wh*-questions featuring a disambiguating strategy able to guide the interpretation of the *wh*-lexical restrictor. A first observation is that all strategies report high percentages of accuracy (Table 7). Similarly, groups do not generally differ in accuracy, however, non-native signers do show a slight overall decrease in accuracy. These values are mirrored in the analysis taking group and type of strategy into consideration, with CODAs and native signers reaching similar values in accuracy in all three strategies and non-native signers slightly below them (Table 6). In general, the percentage of accuracy

for subject clauses is lower than object clauses, with the exception of the Pied-piping strategy where no significant difference in accuracy has been recorded.[14] This is mirrored in the analysis taking into consideration the subject/object accuracy within each strategy (Table 7). When considering the match/mismatch condition of the two NPs in the sentence, answers were less accurate in the matching condition than in the mismatching condition (Table 5), in line with the analysis carried out on ambiguous *wh*-questions. All strategies benefitted from the mismatch in animacy feature of the two NPs, with the exception of the Pointing sign strategy. When introducing groups into the analysis (Table 8), we find out that CODAs and native signers are those who take advantage of the mismatch in animacy feature between the two NPs: the former in sentences with Spatial agreement, the latter both in sentences featuring Spatial agreement and Pied-piping.

Animacy plays a role also when the NP representing the correct answer is a [-animate] object as opposed to a [+animate] one, as shown in Table 9. When considering accuracy as a function of animacy and strategy (Table 10), the facilitating factor of the [-animate] feature is confirmed for the Spatial agreement and the Pied-piping strategies. A somehow unexpected result is the rise in accuracy for [+animate] NPs in the Pointing sign strategy w.r.t. [+animate] NPs in the Spatial agreement and the Pied-piping strategy (regardless of the NPs' grammatical function), as shown in Table 10 and as mirrored in Table 5. A possible explanation is to assume that in LIS pointing signs have a specified [+animate] feature as they share the same phonology with personal pronouns and are often produced next to [+animate] referents in daily conversation (e.g., CHILD_{I} IX_{I} GLASS BREAK 'The child breaks the glass'). Although pointing signs may also co-occur with [-animate] NP referents in LIS ($\text{MAN HOUSE}_{\text{I}}$ IX_{I} BUY WANT, 'The man wants to buy the house'), the data seem to show that LIS signers are more prone to employ them with [+animate] referents. This is confirmed by our Deaf consultants whose intuition is that pointing/indexical signs are widely used accompanying [+animate] NP referents for different purposes (reinforcement, association of the NP referent with a specific point in the signing space for spatial agreement) or for no purpose at all. Things seem to be different for pointing signs referring to [-animate] NPs whose co-occurrence is only allowed, according to our consultants, for referents already introduced in the discourse context, as a focusing strategy. More evidence is needed in order to prove this intuition right.

14. We shall discuss this result below.

4.6.3 The role of animacy

As discussed above, in our experiment, LIS ambiguous and unambiguous WHICH questions elicit an object advantage. Since this advantage seems to be modulated by animacy, with [-animate] NPs carrying out the role of objects reaching higher accuracy responses than [+animate] NPs occurring either as subjects or objects, a possibility is that the object advantage emerging from the study might be a side effect of the inherent [-animate] feature carried by the *wh*-sign we employed.

Animacy is reported to play a role across different studies analysing the subject/object asymmetry in *wh*-questions (cf. Guasti, 1996; a.o.) and relative clauses (c.f. Mak, Wietske & Schriefers 2002; Traxler et al.; Mak, Wietske & Schriefers 2006; Arosio, Guasti & Stucchi 2011; Guasti et al. 2012, a.o.) also in spoken languages. In Guasti (1996), Italian children aged 4-5 years old do not face any problem in the production of subject and object *wh*-questions. Interestingly, the experiment elicited object *wh*-questions featuring nonreversible verbs with the two NPs differing in terms of animacy and employing the *wh*-word *che cosa* ('what' in Italian) specified with a [-animate] feature.

As for relative clauses, Arosio, Guasti & Stucchi (2011) found that 9-year-old Italian-speaking children comprehend object relative clauses with an inanimate head better than relative clauses with an animate head. Guasti, Branchini & Arosio (2012) extended the study to production and found that in 5-year-old children, animacy does not play a role in subject relative clauses, but it does so in object relative clauses, confirming a subject/object asymmetry modulated by the animacy feature in object relative clauses.

4.6.4 Discussing the results against previous studies on sign languages

Let us now compare our results with those emerging from the two previous studies analysing the subject/object asymmetry in *wh*-questions in sign languages presented in §3.3. Cecchetto et al. (2022) study similarly reports an object preference for LIS WHICH questions detected in three adult deaf populations: native, early and late signers. The experiment, however, presents some differences with the present study both in the experimental stimuli and in the elicitation technique employed.

As for the data set, Cecchetto et al.'s (2022) study is composed of WHICH questions displaying rightward movement of the *wh*-sign and of its lexical restrictor (a subset of data in our experiment). While subject questions contain a classifier following the sentence-initial object spatially agreeing with it, object questions do not. In the majority of subject and object questions, the sentence-initial referent (the object in subject

relative clauses, the subject in object relative clauses) is topicalised. As for the elicitation technique, the experiment was carried out through a sentence-to-picture matching task (a pre-recorded LIS video followed by an image displaying three characters performing an action on each other vs. a pre-recorded LIS video simultaneously accompanied by two images showing the two NPs not performing any action in our experiment). Although the object advantage detected across all groups of signers seems to confirm the expectations born out of theoretical proposals pivoting on the linear distance of the moved element to the gap position (e.g., the Minimal Chain Principle), Cecchetto et al. (2022) suggest the object advantage to be affected by the particular configuration of subject relative clauses involving two dependencies (topicalisation and *wh*-movement) developing in opposite directions. Turning to our study, a simple observation is that the object advantage we obtained in LIS WHICH questions in the absence of the peculiar configuration characterising subject relative clauses in Cecchetto et al. (2022) seems to suggest that something different might be at play and that the object advantage might be driven by different factors. As for age of acquisition, Cecchetto et al. found better performances in native signers w.r.t. early and late signers. Similarly, in our study, hearing and deaf native signers behave alike, while late signers score slightly lower in accuracy and show a lower sensibility to the animacy feature carried by the NP arguments.

When turning to Hauser, Aristodemo & Donati's (2023) study, less superficial similarities with our study emerge: as illustrated in §3.3, they look at LSF, a SVO language with *in situ wh*-questions. The authors analyse WHO and WHICH unambiguous questions finding a subject advantage explained in terms of structural factors, the COMP periphery being at the right in LSF, supporting a covert-movement analysis. Similarly to Cecchetto et al.'s (2022) study, Hauser, Aristodemo & Donati (2023) administered a sentence-to-picture matching task to three groups of participants (adult deaf native, early and late signers) finding late learners less competent in the comprehension of LSF object *wh*-questions. Although featuring (covert) movement of the *wh*-sign, LSF shares with LIS the COMP at the right periphery of the clause. Linear accounts would therefore expect both languages to yield an object advantage, as the distance between the gap and the (covertly) moved element is shorter in object questions both in LSF and LIS. Proposals pivoting on the structural distance and hierarchical intervention between the moved *wh*-sign and its gap would predict an opposite direction for the subject/object asymmetry for both languages regardless of linear order or the leftward/rightward position of COMP, that is, a subject advantage.

4.6.5 A linear or hierarchical account?

Let's now return to our study trying to explain the results in light of the findings and theoretical proposals presented in the previous studies on *wh*-questions in spoken and sign languages. We suggest that the object advantage found in LIS WHICH questions, while *prima facie* confirming linear accounts (e.g., Minimal Chain Principle) and discharging structural and hierarchical intervention proposals might hide a more complex picture that we shall try to unfold in what follows. As outlined above, a first observation is that the object preference displayed in both ambiguous and unambiguous sentences is not across the board. When animacy enters the picture, and NP objects are further investigated with more fine-grained analyses, [-animate] object NPs reach higher accuracy scores than [+animate] object NPs revealing that what seems to be crucial in the object advantage of LIS WHICH questions is animacy. Our proposal is that in LIS, the *wh*-word WHICH employed in the data set carries an inherent [-animate] feature (in our data predominantly associated with objects) able to influence the direction of the subject/object asymmetry. This hypothesis seems to find confirmation in the results shown in Table 7 and 11, where the robust preference of participants for object questions displayed in the Spatial agreement and Pointing sign strategies is not mirrored in the Pied-piping strategy (at least in the responses provided by hearing and deaf native signers), where no subject/object asymmetry is found. What is at play here? Why should the asymmetry vanish only in the Pied-piping strategy? Why would the responses targeting object questions lower in accuracy only in this strategy?

A way to explain this result is to assume that hierarchical intervention effects are at play. As predicted by the featural Relativized Minimality, the Pied-piping strategy, involving movement of the NP lexical restrictor together with the *wh*-sign, induces stronger intervention effects in object questions in this disambiguating strategy due to the intervention of the subject NP displaying similar syntactic features with the moved *wh*-phrase (composed of the *wh*-sign and the NP lexical restrictor). If this was the case, stronger intervention effects of the subject in the dependency between the moved object and its gap in the Pied-piping strategy, but not in the other strategies, would erase the object advantage driven by the [-animate] feature carried by the object, yielding a lack of asymmetry. If hierarchical interventions were not at play, we would not be able to account for the lack of asymmetry in the Pied-piping strategy.

Notice that these data are only compatible with a featural Relativized Minimality based on hierarchical intervention and not on a linear one. In fact, if intervention was linear (and not hierarchical) object questions in LIS would be easier than subject questions regardless of the movement

of the *wh-* lexical restrictor to the right periphery of the sentence, as the subject, linearly preceding the object, would not intervene in the dependency between the gap and the moved object. Although speculative, this explanation might support the proposal that the object advantage found in LIS WHICH questions might be driven by animacy features of the *wh*-sign employed and might overshadow a subject advantage, or no asymmetry at all.

In their study, Cecchetto et al. (2022) propose that there is no reason to believe that the subject advantage found in *wh-* questions in spoken languages and driven by hierarchical relations should not hold for sign languages as well.

This proposal seems to be corroborated by Hauser, Aristodemo & Donati's (2023) study showing that, although displaying *in situ wh-* questions and (covert) rightward *wh-* movement, LSF WHO and WHICH questions show a subject advantage.

Further investigation is needed in order to verify whether the direction of the asymmetry in LIS *wh-* questions is really different w.r.t. spoken languages or if the object advantage found might be due to specific features in the experimental stimuli, as proposed in Cecchetto et al.'s (2022) study and in the present one.

4.7 Limitations

A partial limitation of this study is the variability in the stimuli presented, containing an unbalanced number of predicates belonging to the different categories (agreeing, non-agreeing) within each sentence type and lack of balance in animacy features of the two NPs across sentences. Finally, while the overwhelming majority of sentences display an unmarked word order, a few sentences display the marked OSV order (see Footnote 9). As explained, the presence of these items was useful to verify the solidity of the theoretical proposals advanced in the literature, but a future study may opt for uniformity in word order of the sentences in the stimuli presented.

4.8 Future research on the topic

The results and proposals presented in this study should be tested against future research investigating whether the object advantage found in this study is confirmed or can be modulated by different *wh*-signs, especially by WHO-questions.

A comprehension task employing the *wh*-sign WHO would allow for a comparison with the results of the present study. (At least) two possibilities may arise: (i) the direction of the asymmetry does not change, with

object *wh*-questions eliciting higher accuracy rates than subject questions; (ii) the direction of the asymmetry changes with an advantage for subject questions, along the lines of the studies carried out on LSF and on spoken languages.

The first possibility would lead us to dismiss the proposal advanced here that the object advantage of LIS *wh*-questions is due to the inherent [-animate] feature associated with the *wh*-sign WHICH and to call for proposals pivoting on linear order, as the Minimal Chain Principle in order to explain the object advantage. The second possibility would indicate that, regardless of the position of COMP (hence the direction in the movement of the *wh*-element) and of linear order, the subject/object asymmetry in *wh*-questions is based on hierarchical structure in LIS too and that this might be a universal phenomenon across spoken and sign languages.

5 Conclusions

The analysis carried out on the comprehension of LIS ambiguous and unambiguous WHICH- questions shows a marked preference for an object over subject interpretation of the *wh*- lexical restrictor. Such preference is found across groups (CODAs, deaf native and non-native signers) and disambiguating strategies (with the exception of the Pied-piping strategy) and seems to be driven by animacy, with [-animate] objects in the mismatch condition reaching the highest accuracy rate in all disambiguating strategies, except in the Pointing sign strategy. We propose that this is due to the fact that pointing signs in LIS are specified for a [+animate] feature, probably because they share the same phonology with personal pronouns.

Within unambiguous questions, all strategies (Pied-piping, Pointing sign, and Spatial agreement) are effective in guiding the interpretation of the sentences. As for a comparison across groups, they generally do not differ in terms of accuracy, however, non-native signers fall slightly below CODAs and deaf natives in all the three strategies proposed. Furthermore, CODAs and native signers show to be more sensitive to, and better able to take advantage of, the mismatch in animacy feature compared to non-native signers. Age of acquisition seems to play a role in this respect.

Trying to explain the results against the theoretical proposals available in the literature, linear distance accounts, such as the Minimal Chain Principle, could be advocated to explain the object advantage found in the present study. However, the strong correlation between accuracy and animacy in our data along with the lack of a subject/object asym-

metry in the responses provided by CODAs and deaf native signers in the Pied-piping strategy seem to suggest that the picture is more complex.

Our proposal is that the object advantage found in LIS WHICH questions might be a side effect due to the *wh*-sign's specified inherent [-animate] feature (usually associated with objects) whose influence in the participants' responses might affect the direction of the subject/object asymmetry.

Acknowledgements

CB, AB, and GL conceptualised the work. AB supervised by CB and LM took care of data collection. GL analysed the data. All authors discussed the results. CB drafted §1, §2,§4.1, §4.6, §4.7, §4.8, §5; LM drafted §3; AB drafted §4.2 and §4.3; GL drafted §4.4 and §4.5. All authors revised the paper and accepted the present version.

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