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Do visual cues to interrogativity vary between language modalities? Evidence from spoken Portuguese and Portuguese Sign Language

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Abstract

In spoken European Portuguese (EP), eyebrow raising has been considered to be a question marker, as it is the dominant visual cue for questions across regional variants. In Portuguese Sign Language (LGP), it is known that questions are conveyed by a specific facial (and bodily) expression, and that non-verbal correlates for intonation are conveyed by the face, head and upper body, but no detailed information on the prosodic role of non-manuals is available.

The present study explores the role of non-manuals in conveying interrogativity in LGP, focusing on eyebrow and head movements, time-aligned with manuals. Native signers were videotaped while performing an adapted version of the Discourse Completion Task for LGP.

Results show that eyebrow lowering is the dominant non-manual conveying interrogativity, but head can also play this role together with eyebrows. Besides the interrogative wh-word manually articulated, wh-questions differ from yes-no questions in the head movement type: up in the former and down in the latter. In contrast with other signed languages, eyebrow movement does not vary across question types in LGP. Finally, interrogativity in LGP is conveyed by the same facial element (eyebrow) as in spoken EP, the opposite eyebrow movement used suggests its grammaticalization in each language modality.

Index Terms: interrogativity, visual cues, language modality, prosody, Portuguese, Sign Language

1. Introduction

In spoken European Portuguese (EP), eyebrow raising has recently been shown to be the dominant visual cue for questions across varieties, so that it can truly be considered to be a question marker, together with the nuclear pitch accent ([1]).

For Portuguese Sign Language (LGP), little is known about its prosodic grammar. Research on LGP is quite recent, and the first grammatical description and dictionary were only published in the 1990's ([2, 3]). Non-manual markers in LGP are barely documented in these reports, but their role in conveying interrogativity is suggested. Questions in LGP are described as being conveyed by an interrogative adverb or pronoun together with a slight upper body and head tilt towards the interlocutor and with a specific facial expression: namely, half-shut eyes, a furrowed forehead and corners of the mouth turned downwards, alongside manual signals of the meaning of the sentence ([2, p. 127]). More recent studies confirmed that facial expression, head movement and upper body movement indeed function as the non-verbal correlates of intonation in LGP ([4]). However, no detailed information on the prosodic role of these non-manuals is provided.

For other signed languages, eyebrow and head movements have been reported to be question markers that can vary across question types. A typological study covering interrogative utterances across a wide range of geographically and genetically different signed languages shows that non-manuals in questions are highly similar ([5]). Namely, yes-no questions are typically produced with eyebrow raising and head forward and down; wh-questions can be produced both with eyebrow raising or lowering combined with head forward or raising ([5, 6, 7]). Although wh-questions are more variable across signed languages in terms of visual cues time-aligned with manuals, eyebrow lowering is the most frequently used cue ([6, 7, 8, 9]).

The main goal of the present study is to examine the role of non-manuals in conveying interrogativity across spoken and signed modalities of Portuguese, focusing on eyebrow movements and head movements, time-aligned with manuals. Our results should further our understanding of the grammar of LGP, and generate more general insight into how visual cues to interrogativity compare between spoken and signed language modalities. This in turn may help to address the relevance of such cues to enhance communication between hearing and deaf communities.

2. Methodology

In order to allow a comparative analysis between spoken and signed modalities of Portuguese, the same experimental procedure was used to collect semi-spontaneous data. The Discourse Completion Task - DCT ([10, 11]), previously used for spoken EP ([12, 13]), was adapted for LGP, including a total of 56 situations to cover different sentence types, pragmatic meanings and phrasing patterns ([14]). The DCT was adapted by two hearing linguists, one of them trained in LGP, and an interpreter of LGP, who also applied the questionnaire. The latter works on a daily-basis in the deaf association where data collection took place, and thus communication between her and the signers is frequent.

Five native signers of LGP, all deaf women, were videotaped while performing the task. For the analysis, we selected three sentence types: statements, information-seeking yes-no questions, and information-seeking wh-questions. A total of 68 productions (20 statements, 19 information-seeking yes-no questions, and 29 information-seeking wh-questions) were annotated in ELAN ([15]), with detailed information on eyebrow and head movements time-aligned with manuals. In the ELAN grids, 6 tiers of analysis were created: (i) *Glossa*, where manuals are marked-up in uppercase, aligned with the

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time axis; (ii) *Meaning*, where the meaning of the whole sentence is annotated; (iii) *Sentence type*, where the sentence type and pragmatic meaning are indicated; (iv) *Eyebrows*, where the eyebrow movements are delimited and annotated; (v) *Head*, for the delimitation and annotation of head movements; and (vi) *Notes*, for any relevant information, such as the occurrence of non-manuals with lexical properties, thus being inherent to the meaning of the word manually articulated. For instance, the verb BEBER ('to drink') is manually articulated with the thumb pointing to the mouth and a head up movement, which in this case plays a role in the lexical/morphological component of the grammar, thus being clearly unrelated to the prosody of statements and questions.

Labels used to annotate eyebrow and head movements follow a simplified version of the FACS – Facial Action Coding System ([16]). Thus, for eyebrow movements the following labels were considered: (i) *eyebrows neutral* (i.e., no eyebrow movement); (ii) *eyebrows raising* (AU1/AU2); and (iii) *eyebrows lowering* (AU4). For the annotation of head movements, the labels considered were: (i) *head neutral* (i.e., no head movement); (ii) *head up* (AU53); (iii); *head down* (AU54), also including the *head nod up-down* (AU54 repeatedly produced); (iv) *head turn left* (AU51); (v) *head turn right* (AU52); (vi) *head tilt left* (AU55); (vii) *head tilt right* (AU56); (viii) *head forward* (AU57); (ix) *head backward* (AU58).

At a first step, data annotation was done by the linguist trained in LGP. Then, two additional annotators coded the total of sentences under analysis: one of them is an expert annotator of pointing gestures and the other is naive. None of them knows (or have contact with) LGP (signers). They were asked to perform a blind annotation in the sense that they only had access to tiers (iv) and (v) with blank intervals time-aligned with the video. They had no information about glosses, sentence type or meaning being produced. Tier (vi) was kept in the raters' grids, but only information on non-manuals providing lexical information was kept, in order to avoid biased annotations. In order to control for variability in their codes, they were provided with a controlled vocabulary containing the FACS labels mentioned above. Each annotator had to double-click in each time interval and to choose the label that better described the eyebrow and the head movement occurring in its time span. At the end, they were asked to revise all their annotations in order to ensure internal consistency in the labeling task performed.

Following Landis & Koch's interpretation of kappa [17], a moderate inter-rater agreement was found for the annotation of eyebrows (Fleiss κ=.43), with a higher agreement score in information-seeking yes-no questions (Fleiss κ=.42) than in statements and information-seeking wh-questions, and a fair inter-rater agreement for the annotation of head movements (Fleiss κ=.24), with a higher agreement score in statements (Fleiss κ=.37) than in the two interrogative types considered. Since the two additional annotators have different backgrounds (expert and naive), Cohen's kappa was also computed to generate pairwise inter-rater agreement scores. A moderate agreement was found between the trained linguist in LGP and the expert annotator for the eyebrows (Cohen's κ=.56). When considering information-seeking yes-no questions, the sentence type with the highest agreement score, a similar kappa (moderate) was found between the trained linguist in LGP/expert annotator pair (Cohen's κ=.47) and the trained linguist in LGP/naive pair (Cohen's κ=.43). For head movements, a substantial agreement was found between the trained linguist in LGP and the naive annotator (Cohen's κ=.70).

3. Results

An overall analysis of all possible nonmanuals per sentence type reveals that, similarly to the results reported for spoken EP ([1]), visual cues (eyebrow and head movements) time-aligned with manuals vary. However, there is clearly less variability in LGP than in spoken EP. Also in contrast with spoken EP ([1]), statements show greater variability of visual cues than questions, which seems to point to two main observations: (i) different degrees of grammaticalization of a given non-manual depending on the prosodic meaning conveyed, and (ii) different degrees of grammaticalization of the same visual cue depending on the language modality.

Additionally, there is more variability in yes-no questions than in wh-questions, which can also be due to the fact that wh-questions are mainly (but not exclusively) signaled by the manual articulation of interrogative adverbs and pronouns, consistently expressed by specific non-manuals time-aligned with manuals.

In the following sections, non-manuals are described in detail by sentence type.

3.1. Statements

Statements in LGP are mainly produced with manuals, as *no (non-manual) gestures* is the dominant (50%) category in the data (Figure 1).

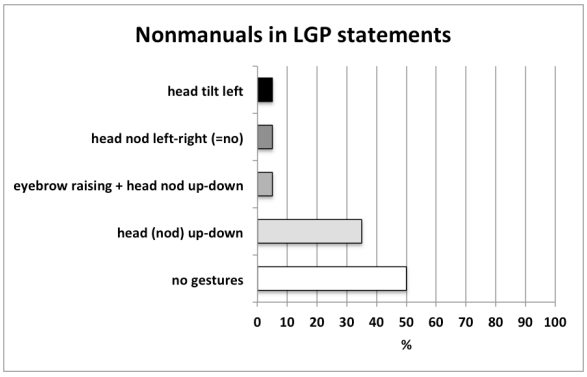


Figure 1: *Nonmanuals (eyebrow and head movements) in LGP statements.*

When head movement occurs the dominant one is the *head (nod) up-down* (35%), which also characterizes statements in spoken EP ([1]). Eyebrow movements are scarce. Actually, the *eyebrow raising* only occurred once and in combination with a *head nod up-down* (5%).

3.2. Information-seeking yes-no questions

In LGP, information-seeking yes-no questions are mainly produced with an eyebrow lowering together with head (nod) up-down (63%), as shown in Figure 2. Additionally, each of these non-manuals – eyebrow lowering (11%) and head (nod) up-down (21%) – can also occur in isolation.

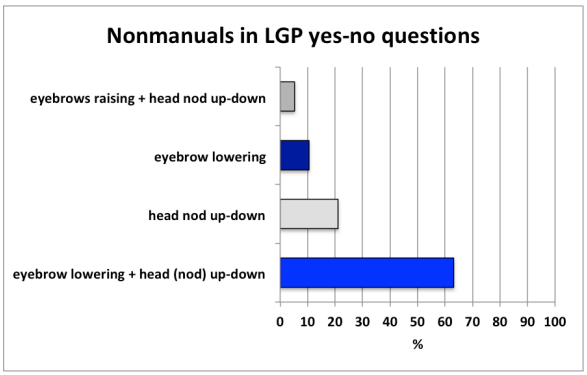


Figure 2: *Nonmanuals (eyebrow and head movements) in LGP information-seeking yes-no questions.*

Thus, differently from statements (Figure 1), information-seeking yes-no questions are mainly marked by the eyebrow lowering movement (blue bars in Figure 2), even if mostly combined with the head (nod) up-down movement, as illustrated in Figure 3.

CHAMAR MÃE COMPRAR JÁ BANANA
CALLING MOTHER TO BUY ALREADY BANANA
('Look, did mother buy bananas?')

Figure 3: *Frame of BANANA ('banana') extracted from an information-seeking yes-no question. Glossas and meaning provided below the frame. Video file corresponding to the production of the full sentence is available (P3_yes-noQ.mpg).*

The other non-manuals represented in grey bars (head nod up-down alone and eyebrows raising together with head nod up-down) may also occur in statements. Thus, they are not considered as exclusive markers of information-seeking yes-no questions.

Interestingly, the eyebrow lowering in LGP yes-no questions was unexpected for two main reasons. First, a typological overview of interrogative utterances in signed languages ([5]) describes yes-no questions as being typically produced with eyebrow raising, which is the opposite movement to the one found for the same non-manual in LGP. Second, the eyebrow lowering in LGP contrasts with the eyebrow raising that was found in the production of the same sentence type in spoken EP ([1]). Thus, although the same facial body part is been used between language modalities, the movement, and thus the actual visual cue, is different.

3.3. Information-seeking wh-questions

Showing less variability in visual cues than yes-no questions (Figure 2), information-seeking wh-questions in LGP are mainly produced with an eyebrow lowering together with a head up movement (Figure 4).

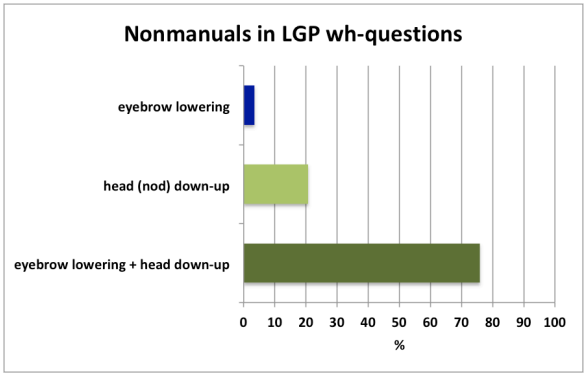


Figure 4: *Nonmanuals (eyebrow and head movements) in LGP information-seeking yes-no questions.*

Similarly to yes-no questions, each of these non-manuals – eyebrow lowering (3%) and head up movement (21%) – may occur separately from each other, but with a lower frequency than when combined.

When comparing non-manuals of yes-no questions and wh-questions in LGP (Figure 2 *versus* Figure 4), two main conclusions can be drawn. First, the eyebrow lowering is common to both types of questions, which suggests that it is grammaticalized as the question marker in LGP. Second, wh-questions differ from yes-no questions in the type of head movement – up in the former and down in the latter –, thus suggesting that head up is the relevant feature of wh-questions, similarly to what has been reported for most signed languages ([5, 6, 7, 8, 9]). Moreover, this also provides evidence for a componential analysis of nonmanuals ([6]), as interrogativity is conveyed by an eyebrow movement and the interrogative type is conveyed by a specific head movement simultaneously articulated with the eyebrow movement.

Finally, it is important to highlight that this sentence type is not always produced with interrogative adverbs and pronouns manually articulated. Nevertheless, the eyebrow lowering together with a head up movement is present. The consistency of non-manuals independently of the manual articulation of wh-words can be observed from the comparison between Figure 5 (with interrogative pronoun) and Figure 6 (without interrogative pronoun).

Besides showing that the head up movement does not have lexical properties, i.e., it is not part of the production of the interrogative adverb or pronouns, this finding reinforces the prosodic role of the head up movement to convey wh-questions in LGP.

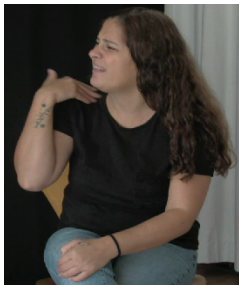
3.4. Comparing sentence types

Wilcoxon tests were run in order to compare the distribution of non-manuals across sentence types. Results support the quantitative descriptive analysis presented above. Non-manuals used in statements are significantly different from non-manuals used in information-seeking yes-no questions (Z=-4.308, p<.05) and in information-seeking wh-questions (Z=-4.052, p<.05). By contrast, non-manuals used in information-seeking yes-no questions are not significantly different from the ones used in information-seeking wh-questions (Z=-1.840, p=.066). Eyebrows and head movements were then compared, separately, between the two interrogative

types. Results show that eyebrow movements of information-seeking yes-no questions are not significantly different from the ones used in information-seeking wh-questions (Z=-.452, p=.651), which highlights the role of the eyebrows as an interrogative marker. Head movements, by contrast, significantly differ between the two types of questions (Z=-4.119, p<.05), thus showing that the distinction between these two interrogative types in LGP lies in the head movement.

DESCULPA A TI ELA CONTAR O QUÊ
EXCUSE ME TO YOU SHE TO TELL WHAT
('Excuse me, what did she tell you?')

Figure 5: *Frame of O QUÊ ('what') extracted from an information-seeking wh-question. Glossas and meaning provided below the frame. Video file corresponding to the production of the full sentence is available (P3_wh-Q.mpg).*



GESTO MANUAL [=SANTANA]
MANUAL GESTURE [=SANTANA]
('This manual, what does this mean'? [Santana is the name of a known politician in Portugal]).

Figure 6: *Frame of the manual gesture used in LGP to name Santana Lopes, a known politician in Portugal, corresponding to an information-seeking wh-question without interrogative pronoun. Glossas and meaning provided below the frame. Video file corresponding to the production of the full sentence is available (P4_wh-Q.mpg).*

4. Conclusions

In this study the role of non-manuals for conveying interrogativity in LGP was examined, focusing on eyebrow movements and head movements time-aligned with manuals. Additionally, these visual cues were compared with the ones found in spoken EP, to learn about similarities and differences between the two language modalities. The same experimental procedure used to collect semi-spontaneous data in spoken EP – the DCT – was thus implemented in LGP.

A general analysis of non-manuals used in statements, information-seeking yes-no questions and information-seeking wh-questions in LGP revealed that non-manuals vary more in statements than in questions, and that wh-questions are accompanied by a more limited range of non-manuals. This clearly contrasts with visual cues in spoken EP, where a higher degree of variability can be observed in yes-no questions than in statements ([1]).

A more focused analysis of non-manuals per sentence type shows that, although showing the highest variability, statements are mainly produced with manuals, as no facial/head movements are produced in the majority of cases. In contrast, questions are homogeneously signaled by an eyebrow lowering, which seems to be the question marker in LGP. Differently, in spoken EP, the question marker is the eyebrow raising movement instead. Additionally, the distinctive feature between yes-no and wh-questions lies in the head movement – down in the former and up in the latter.

These results clearly point to two main suggestions. First, LGP is at variance with the majority of signed languages, at least from a prosodic perspective. Interrogatives in most of the studied signed languages so far are typically produced with an eyebrow raising, which is a different visual cue to the one found in LGP, and yes-no questions usually differ from wh-questions both in eyebrow and head movements, which is not the case in LGP where only the head movement changes. Nevertheless, a similar componentiality of nonmanuals was found in LGP, like in other signed languages, thus showing that although LGP differs from other signed languages in the type of nonmanual movements selected, the underlying system is similar, as the same nonmanuals are used in a combinatory way. Second, it seems evident that eyebrows play an important prosodic role in Portuguese, both in spoken and signed modalities, which suggests the grammaticalization of this visual cue, together with the contrasting eyebrow movements between modalities. The impact of similarities and differences in visual cues across modalities for communication between hearing and deaf communities is not known yet. Since visual cues are used by spoken and signed modalities to convey prosodic meanings, they seem to be undoubtedly relevant to enhance communication between speakers and signers. This is left for future study.

Finally, the reason why eyebrows tend to be universally used to mark interrogativity may relate, from an evolutionary perspective, to the change from the large browridges of our immediate ancestors to the vertical frontal bone in modern humans that provided the advantage of having highly mobile eyebrows to display multiple meanings ([18]), which act as social signals ([19]): eyebrow raising being generally associated with positive meanings (e.g., friendliness, sympathy, happiness, willingness to interact) and eyebrow lowering with more negative meanings ([19, 20]). The ways languages may use these general meanings and eventually incorporate them in their prosodic grammars may vary, as in the case of other biological or adaptative grounded prosodic features that get grammaticalized ([21]).

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