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RESEARCH

The role of prosody in overt pronoun resolution in a null subject language and in a non-null subject language: A production study

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In this study, we investigate how prosodic cues are used when an overt pronoun is associated with either a subject or an object antecedent in Italian and in Swedish. To address this question, 28 Italian speakers and 28 Swedish speakers completed a production task, by reading out loud globally-ambiguous sentences containing overt pronouns and a control interpretation task, where they selected either a subject or an object antecedent for each pronoun, contained in a globally-ambiguous sentence. We expected that the different preference patterns in antecedent assignment in the two languages would affect the speakers' use of prosody. In Italian, overt pronouns are usually associated with object antecedents, whereas null pronouns are usually associated with subject antecedents (*Position of Antecedent Strategy* – "PAS" – Carminati 2002). On the other hand, Swedish overt pronouns leave a measure of ambiguity with respect to antecedent assignment. The results of the control interpretation task confirmed that the Italian speakers conformed to the PAS, but the results for the Swedish speakers unexpectedly indicated a preference for subject antecedents. For the production task, the Italian speakers produced longer inter-clausal pauses and pronouns with a higher degree of prominence with subject rather than object antecedents. In contrast, the Swedish speakers produced longer pauses and pronouns with a higher degree of prominence with object rather than subject antecedents. These results suggest that inter-clausal pause and prosodic prominence favoured the most unpredictable antecedent of overt pronouns (see Goad et al. 2018): the subject in Italian and the object in Swedish.

Keywords: prosody; pronominal anaphora resolution; Null Subject Parameter; production study

1 Introduction

Prosody represents a relevant source of information for the accessibility and predictability of a linguistic item (for an overview see Wagner & Watson 2010). The prosodic features of a target syllable, word or utterance are likely to affect the information status of an item, such as a pronoun. In the current study, we investigate how Italian and Swedish speakers use prosodic features to associate overt pronouns with either a subject or an object antecedent (production task), and whether the two groups show different preference patterns in antecedent assignment (control interpretation task).

First of all, studies with a focus on different languages suggest that prosody affects pronoun resolution (De Hoop 2004; Jasinskaja, Kölsch & Mayer 2005; Rello & Llisterri 2012; McClay & Wagner 2014; Goad et al. 2018, among many others). For example, in a perception study, Goad et al. (2018) demonstrated that the presence of stress on Italian overt pronouns is likely to change the canonical pattern of antecedent assignment for these pronouns.

Secondly, we focused on two prosodic features that may affect pronoun resolution, i.e., pause and acoustic measures of prominence (see Jasinskaja et al. 2005; Rello & Llisterri 2012; Goad et al. 2018, among others). With regard to the use of pause, we measured the inter-clausal pause duration, i.e., the duration of the pause between main clause and subordinate clause (see Goad et al. 2018). In relation to the prosodic prominence of pronouns, we analyzed three acoustic measures that are generally considered primary predictors of prominence: length, intensity and F0 (see Terken & Hermes 2000).

Thirdly, we predicted that the Italian speakers would use pause and prosodic prominence differently from the Swedish speakers, because we expected that the preference patterns in antecedent assignment would differ in the two languages. In fact, experimental research on intra-sentential anaphora resolution has shown that, according to the *Position of Antecedent Strategy* (“PAS” – Carminati 2002), Italian speakers generally associate null pronouns with the antecedent in the highest SpecIP of the syntactic phrase structure (usually the subject) and overt pronouns with an antecedent in a position hierarchically lower than the SpecIP (usually the object). An example is given below, where ‘pro’ indicates a null pronoun (see example 1). On the other hand, Swedish leaves a measure of ambiguity when it comes to assigning the overt pronoun to an available antecedent, i.e., either the subject or the object of a preceding clause, like in (2). This means that Italian overt pronouns are generally associated with object antecedents and null pronouns are generally associated with subject antecedents, like in (1), while Swedish overt pronouns do not have a canonical pattern in antecedent assignment, since they can be associated with subject and object antecedents equally, like in (2).

- (1) *Italian*
 Riccardo_i ha conosciuto Diego_j quando **pro**_i/ lui_j lavorava in una clinica
 Riccardo has known Diego when he worked in a clinic
 privata.
 private
 ‘Riccardo met Diego when he was working in a private clinic.’
- (2) *Swedish*
 Per_i lärde känna Martin_j när han_{i/j} arbetade på en privatklinik.
 Per got know Martin when he worked for a private clinic
 ‘Per met Martin when he was working in a private clinic.’

In the present study, a speech production experiment was designed to explore how Italian and Swedish speakers use prosody when they have to assign an overt pronoun to either a subject or an object antecedent. Furthermore, a control interpretation experiment was designed to investigate whether Italian speakers conform to the PAS (Carminati 2002), like in (1), and whether Swedish speakers show a measure of ambiguity in antecedent assignment, like in (2). Both experiments include globally ambiguous sentences, i.e., sentences with an ambiguous general meaning (e.g., *Riccardo met Diego when he was working in a private clinic*).

We argue that Italian and Swedish speakers use prosody differently to resolve an anaphora because the two languages present different preference patterns in antecedent assignment. These different patterns are related to the presence of two alternatives of the same linguistic structure in one language, but not in the other (i.e., null and overt pronouns in Italian vs. overt pronouns in Swedish).

2 The role of prosody in pronoun resolution

As mentioned above, previous studies have investigated the interplay between prosody and pronoun resolution, both in perception and production studies, focusing on various prosodic features, such as pitch accents, nuclear accent placement, stress, and intra-segmental pause duration (De Hoop 2004; Jasinskaja, Kölsch & Mayer 2005; 2007; Rello & Llisterri 2012; McClay & Wagner 2014; Goad et al. 2018, among others). Despite the different methods, parameters and languages involved, prosody is likely to represent an important source of information for the interpretation of an anaphoric reference (Rello & Llisterri 2012). An open issue on the role of prosody in anaphora resolution concerns the identification of the prosodic parameters, which mostly affect the interpretation of ambiguous pronouns.

In a production study, Rello & Llisterri (2012) explored the role of duration of pronouns, F0 movement, amplitude of the segment, pause duration and pause occurrence in the interpretation of ambiguous pronouns in Spanish. Six stories were visually presented to the participants, each containing a target clause with an ambiguous pronoun like *ella* 'she' in (3). After a silent reading, the participants completed an interpretation task, to ensure that the expected antecedent was identified, and were then recorded while reading the story. The main prediction was to find differences between the pronoun close to the antecedent and the pronoun far from the antecedent with respect to speakers' use of prosodic factors.

(3) *Spanish* (Rello & Llisterri 2012)

Ainara compraba una nube de azúcar mientras Pilar se comía
Ainara was buying a cloud of sugar while Pilar herself was eating
un helado; luego, ella se subió a la noria.
an ice cream then she herself got on to the Ferris wheel
'Ainara was buying a sugar cloud while Pilar was eating an ice cream; then, she
got on to the Ferris wheel.'

The results showed first, that the pause between the discourse connector *luego* 'then' and the pronoun *ella* 'she' was longer with further antecedents, than with closer antecedents. Secondly, the pronoun's duration was shorter with further antecedents, than with closer antecedents. Thirdly, the difference between the two conditions was larger when the mean pronoun's F0 range was larger in the further antecedent condition rather than in the closer antecedent condition. This outcome was explained by inter-speaker variation in the maximum value of F0. The data on amplitude did not show any regular tendency. The authors concluded that prosody might play a role in anaphora disambiguation in Spanish, despite the inter-speaker variation found in the data, and with the exception of the intensity parameter.

In a key-study for the present paper, Goad et al. (2018) investigated whether prosody impacts the resolution of null and overt pronouns in a group of intermediate and advanced second language (L2) learners of Italian (with Dutch and English as native languages) and in a group of native speakers (L1) of Italian. The aim of this paper was to explain some inconsistent results found in previous studies on pronoun resolution (e.g., Sorace & Filiaci 2006; Belletti, Bennati & Sorace 2007). The general prediction was that the speakers would interpret sentences with an inter-clausal pause or with a stressed pronoun differently from sentences without an inter-clausal pause or with an unstressed pronoun.

Target sentences containing an intra-sentential anaphora, such as (4), were acoustically presented to participants, whose task was to assign the pronoun (either null or overt) to one of three possible antecedents (i.e., subject antecedent, object antecedent or third external referent), by answering a visually presented *who?*-question. A previous sentence, containing information about the context, was visually presented to introduce the third external referent. Goad et al. (2018) manipulated three factors: pronoun (null pronoun vs. overt pronoun, indicated respectively by ‘pro’ and *lui/LUI* in example 4), inter-clausal pause (pause vs. no pause, indicated by ‘(#)’ in example 4), and stress (unstressed vs. contrastive, indicated respectively by *lui* and *LUI* in example 4).

- (4) *Italian* (Goad et al. 2018)
 Lorenzo ha scritto a Roberto (#) quando **pro**/ lui/ LUI si è
 Lorenzo has written to Roberto when he HE himself is
 trasferito a Torino.
 moved to Turin
 ‘Lorenzo wrote to Roberto when he moved to Turin.’

The results showed first that both groups (L1 and L2) selected objects for overt pronouns and subjects for null pronouns and reduced the object assignment when the pronoun was stressed. Secondly, the presence of contrastive stress on the pronoun increased the external referent assignment for L2 speakers, increased the subject assignment for L1 speakers, and reduced the selection of subjects for overt pronouns in the group of intermediate L2 speakers. Surprisingly, the pause did not affect the interpretation of pronouns. These findings suggest that prosody affects pronoun resolution in both L1 and L2 speakers. However, it is important to underline that the L1s of the group of L2ers (i.e., Dutch and English) were not tested in this study. Furthermore, contrary to Goad et al. (2018), we did not focus on the role of pronoun stress but we considered the role of prosodic prominence (in addition to inter-clausal pause).

As regards the notion of prosodic prominence, we followed the viewpoint of Wagner et al. (2015), who stated that the most effective approaches to prominence are the broader ones and we adopted the following definition by Terken & Hermes (2000):

We say that a linguistic entity is prosodically prominent when it stands out from its environment by virtue of its prosodic characteristics. That is, we define prominence as a property of a linguistic entity relative to an entity or a set of entities in its environment. [...] In the acoustic domain, the primary prosodic properties bringing about these relative differences are amplitude, duration and ‘F0’ (we use F0 as a shorthand form for the inverse of the quasi-periodicity of the speech signal). The corresponding perceptual properties are loudness, duration or length, and pitch. (Terken & Hermes 2000: 89)

In a review on different approaches to the relationship between prosodic phrasing and prosodic prominence, Wagner & Watson (2010) described the importance of the notion of predictability. In fact, unpredictable but also non-frequent items are more likely to lend acoustic parameter of prominence than predictable or frequent items, as shown in different studies (Bell et al. 2002; Aylett & Turk 2004; Gahl & Garnsey 2004, among others).

In a perception study, Baumann & Roth (2014) explored the relationship between prominence and information structure by testing native German speakers in a web-based experiment. Three prosodic parameters that are “most relevant for the perception of post-lexical prominence” (Baumann & Roth 2014: 227), i.e., F0 movement, duration and intensity,

were manipulated on target words. The first prediction was that the more prominent the antecedent, the lower the probability it would be judged as the referent of the anaphoric relationship. The second prediction was that the prosodic parameters have a different impact on the perception of prominence, with the F0 movement having the strongest effect, followed by duration and, finally, intensity. Target sentences like (5b) were acoustically presented to the participants, whose task was to respond to a visually presented question like (5c), judging the probability that an anaphora referred to a specific antecedent (on a gradient scale). Each target sentence like (5b) was preceded by a visually presented question, containing information about the context, like in (5a).

- (5) *German* (Baumann & Roth 2014)
- a. Hast du deine Cousine getroffen?
have you your cousin met
'Have you met your cousin?'
 - b. Montag habe ich Tamara getroffen.
Monday have I Tamara met
'On Monday I met Tamara.'
 - c. Für wie wahrscheinlich halten Sie es, dass es sich bei der
for how likely think you it that it itself for the_DAT.SG.
Cousine um Tamara handelt?
cousin about Tamara is
'How likely do you think it is that the cousin is Tamara?'

F0 movement, duration and intensity of the stressed syllable of the potential antecedent (e.g., *Tamara* in example 5b) were manipulated. The F0 movement's manipulation was divided into a rising condition (190 Hz–240 Hz), a falling condition (240 Hz–190 Hz) and a level condition (190 Hz–190 Hz). The duration of the syllable included a short condition (150 ms) and a long condition (200 ms), and the intensity was either loud (57 dB) or soft (47 dB). Finally, the prosodic context of the sentence was controlled. The results show a significant effect for F0 movement, i.e., non-coreference is associated with a change in tonal movement while coreference is associated with a lack of tonal movement. This result was more significant for rising tones than for falling tones. Furthermore, duration was significantly correlated with non-coreference, i.e., a test word with a long syllable was judged as less of a co-referent rather than a test word with a short syllable. Contrary to the authors' predictions, intensity did not show any significant effect and no significant interaction was found between the three factors. The authors concluded that the perceived prominence was generally correlated to non-coreference and that F0 movement was the main predictor for prominence.

3 Null pronouns, overt pronouns and antecedent assignment

Null subject languages, such as Italian, are languages that allow the subject of a finite clause to be left phonetically unexpressed (D'Alessandro 2015). Non-null subject languages such as Swedish require the phonetic realization of the subject in finite clauses, with some exceptions. This linguistic variation with respect to the Null Subject Parameter affects argument structure and coreference (Sornicola 1996).

In relation to coreference, a non-null subject language such as Swedish, leaves a measure of ambiguity when it comes to identifying the antecedent of an overt pronoun (see example 2). On the other hand, Italian shows a division of labour between null and overt pronouns (see example 1), as reported in Carminati (2002).

Carminati (2002) conducted a series of experimental tests in Italian, asking participants to complete an interpretation task on different types of clauses containing null and overt pronouns. As mentioned above, the results of this study suggest that, in an intra-sentential anaphora, Italian speakers associate null pronouns with the antecedent in the highest SpecIP of the phrase structure (usually the subject) and associate overt pronouns with an antecedent in a syntactic position lower than the SpecIP of the phrase structure (usually the object), as shown in (1).¹ This theory is known as the *Position of Antecedent Strategy* (PAS) and represents the basis of a large body of research on monolingual and bilingual anaphora resolution in different languages (Sorace & Filiaci 2006; Kaltsa, Tsimpli & Rothman 2015; Papadopoulou et al. 2015; Chamorro, Sorace & Sturt 2016, among many others). The PAS refers to the Italian strong pronouns *lui/lei* but not to their alternative weak forms *egli/ella*. In fact, the latter forms are rarely present in modern Italian and usually pertain to written and formal registers (Carminati 2002: 9).

Interestingly, Carminati (2002) underlined the potential effects of stress when it comes to pronoun interpretation, but the PAS “only covers cases where the null/pronoun alternation is possible, so it does not apply in contexts with contrastive or emphatic stress” (Carminati 2002: 320).² Nevertheless, to the best of our knowledge, only the study of Goad et al. (2018) addressed the role of prosody in anaphora resolution in relation to null/overt pronoun alternation in Italian in globally-ambiguous sentences such as (1), conducting a perception test (this study was described in Section 2).

With regard to overt pronouns, the Italian subject pronouns *lui/lei* present similar syntactic features to the Swedish subject pronouns *han/hon*, since they all function as full noun phrases and, therefore, are considered strong pronouns (see Cardinaletti & Starke 1999; Hellan & Platzack 1999; Granfeldt & Schlyter 2004). In spoken Swedish, the opposition between strong and weak subject pronouns is connected to their accentuation (Hellan & Platzack 1999).³ In the present experiment, we tested whether and how speakers elicit a plausible contrast through pauses and acoustic features of prominence, which is not only a matter of the categorical status of the pronoun (i.e., strong or weak). For this reason, the opposition between strong and weak pronouns remains beyond the scope of the present discussion.

4 The present study

In the current study we investigate how Italian and Swedish speakers use prosody to resolve an anaphora, and whether their use of prosody reflect different preference patterns in antecedent assignment in the two languages. To address these questions, 28 native Italian speakers and 28 native Swedish speakers completed a production task (to test prosody) and a control interpretation task (to test preferences in antecedent assignment). Moreover, a background questionnaire was included to attain the participants' linguistic profiles. Specifically, this study addresses the following research questions, where RQ 1 refers to the production task and RQ 2 to the control interpretation task:

¹ The PAS focuses on a positional bias of the pronouns. This means that a null pronoun is associated with the antecedent in the highest position of the phrase structure even when this antecedent is not the grammatical subject of the sentence (e.g., *A Mario DAT piaceva Fabio quando era giovane*, ‘Mario liked Fabio when (he) was young’). However, in the target sentences of the present study the grammatical subjects of the main clauses always occupy the highest position of the phrase structure.

² Cartographic studies by Rizzi & Bocci (2017) have shown the complexity of the interaction between word order, prosody and information status in Italian.

³ In Swedish, subject pronouns are necessarily accentuated (strong) in certain positions, i.e., when they occur after an adverb or after a negation (Hellan & Platzack 1999).

- RQ 1a) Do Italian speakers produce longer inter-clausal pauses and pronouns with a higher degree of prominence when the antecedent corresponds to the subject rather than to the object?
- RQ 1b) Do Swedish speakers avoid producing longer inter-clausal pauses and pronouns with a higher degree of prominence in any of the two conditions (i.e., subject antecedent and object antecedent)?
- RQ 2a) Do Italian speakers assign overt pronouns to object antecedents and null pronouns to subject antecedents, conforming to the PAS?
- RQ 2b) Do Swedish speakers avoid having a preference for either subject or object antecedents when they interpret overt pronouns, reflecting the underlying ambiguity of pronoun resolution in this language?

In relation to previous work, we considered the role of pause and acoustic measures of prominence on pronoun resolution (see Jasinskaja et al. 2005; Rello & Llisterri 2012; Goad et al. 2018, among others). Furthermore, according to Terken & Hermes (2000: 89), length, intensity and F0 are the primary predictors of prosodic prominence, the same prosodic features we used in this study (in addition to pause). A description of how we calculated those acoustic measures is given in Section 5.4. We had different predictions for how Italian and Swedish speakers would use prosody when they resolve an anaphora.

First, we expected that, when the antecedent corresponded to the subject instead of the object, the Italian speakers would show a longer inter-clausal pause duration, i.e., a longer pause between the main clause and the subordinate clause (PRED 1) and a pronoun with a higher degree of prominence (PRED 2). The pronoun’s degree of prominence was measured in terms of the pronoun’s relative length, the pronoun’s average F0 range and the pronoun’s relative intensity. We based these predictions on the assumption that prominence and pause would break the canonical pattern of coreference in Italian, favouring the unpredictable antecedent, i.e. the subject (see Goad et al. 2018). Secondly, in Swedish we expected no difference between sentences with a subject antecedent and sentences with an object antecedent for the inter-clausal pause duration (PRED 3) and for the pronoun’s degree of prominence (PRED 4). Thirdly, in relation to the control interpretation task, we expected that the Italian speakers would conform to the PAS, assigning object antecedents to overt pronouns, and also subject antecedents to null pronouns (PRED 5), as shown in example 1. We also expected that the Swedish speakers would show no preference for either subjects or objects in the assignment of the antecedent, as in example 2 (PRED 6). Table 1 shows a summary of our predictions on overt pronoun resolution.

Table 1: Summary of our predictions on overt pronoun resolution.

Object of analysis	Predictions				Level of analysis	Experimental task
	Italian		Swedish			
	sbj	obj	sbj	obj		
Inter-clausal pause duration & degree of prominence	>	<	=	=	Prosody	Production task
Antecedent assignment	-	+	=	=	Syntax-pragmatics	Control interpretation task

Note: Concerning the prosodic level of analysis, the symbol “>” stands for “pronouns with a higher degree of prominence” and “longer pauses”, the symbol “<” stands for “pronouns with a lower degree of prominence” and “shorter pauses”, while “=” stands for “equal degree of prominence” and “equally long pauses”. Concerning the syntactic-pragmatic level of analysis, the symbol “+” stands for “predictable”, the symbol “-” for “unpredictable” and the symbol “=” for “equally predictable”.

For the analysis of the production data, we used gradient values (i.e., higher/lower degree of prominence, longer/shorter pause) instead of discrete values (i.e., prosodically prominent vs. not prosodically prominent and pause vs. no pause) to take into account the cross-linguistic differences between Italian and Swedish. Furthermore, we did not compare absolute differences between Italian and Swedish but only compared how prosodic cues are used within each language for the two conditions (subject antecedent and object antecedent).

5 Method

5.1 Participants

The production task, the control interpretation task and the background questionnaire were completed by 28 native speakers of Italian and 28 native speakers of Swedish. Two versions of the three tests were created, one in Italian and one in Swedish. The Italian group was tested in Italy, at the National Research Centre of Rome, while the Swedish group was tested in Sweden, at Lund University. They received movie tickets or book coupons for their participation in the study.

The first group was comprised of adult native speakers of Italian (17 males, 11 females), who were born and had grown up in Italy, where they had lived for most of their life. In fact, only two speakers had ever lived abroad, and for just one year. They were between 20 and 62 years old (the mean age was 32.75 years old), their parents were both native Italian speakers, with one exception.⁴ Furthermore, none of them knew any other language from birth and nobody spoke Swedish. The Italian participants had acquired a higher level of education than the Swedish group, which consisted mainly of university students at undergraduate level. Five Italian participants had a PhD, eleven had a Master's degree, six had a Bachelor's degree and six had a high-school diploma. The participants rated the frequency of use of their native language on a five-point scale in three different contexts (work, home, in other social situations). The Italian participants used to speak their native language in each of the three given contexts, giving an average result of 5.00 on the five-point scale.

The second group was comprised of native speakers of Swedish (6 males, 22 females), who were born and had grown up in Sweden, where they had lived for most of their life (only two of them had lived abroad for more than one year). The Swedish speakers were between 19 and 54 years old (the mean age was 31.29 years old). They did not speak any other language from birth and nobody spoke Italian. All of their parents were both native speakers of Swedish. With regard to their level of education, two participants had a PhD, five had a Master's degree, five had a Bachelor's degree and sixteen had a high-school diploma. The sixteen participants with a high school diploma, three participants with a Bachelor's degree and one with a Master's degree were studying at the university when the test was done. The Swedish participants used to speak their native language in each of the three given contexts (work, home, in other social situations), giving an average result of 4.94 on the five-point scale. Both groups reported the use of a second language (usually English), which was rated on average 3.15 on the five-point scale for the Swedish group, and on average 1.95 on the five-point scale for the Italian group.

5.2 Materials

5.2.1 The production task: Prosodic cues of pronoun resolution in Italian and in Swedish

In the production task, the participants were recorded while reading sentences presented on a computer screen out loud. The stimuli of the production task consisted of 20 target items and 20 fillers, both of them were repeated twice over the course of the experiment.

⁴ One participant's father was bilingual but he used to speak exclusively Italian at home. For this reason, this participant was included in the study.

After all 40 items (20 target and 20 fillers) had appeared, a new session began with the same items, presented in a different order. The repetition of the same items twice allowed us to ensure that participants were using prosodic cues systematically. The items were pseudo-randomized and each target item was preceded and followed by a filler.

Each target item consisted of two sentences: a context-sentence (Sentence One), which contained information about the situational context, followed by the sentence of interest (Sentence Two), i.e., a globally ambiguous sentence containing an overt pronoun (see Supplementary file). Specifically, Sentence Two consisted of an intra-sentential forward anaphora, with a main clause followed by a temporal clause introduced by the subordinate conjunction *quando* ‘when’ (in the Italian test) or *när* ‘when’ (in the Swedish test), and the overt pronoun (see examples 7 and 9, respectively). Half of the target sentences included a feminine pronoun (i.e., *lei* ‘she’ in Italian, and *hon* ‘she’ in Swedish), and the other half a masculine pronoun (i.e., *lui* ‘he’ in Italian, and *han* ‘he’ in Swedish). Sentence Two was globally ambiguous, i.e., the general meaning of the sentence was ambiguous, like in (7) and (9). On the other hand, Sentence One indicated who was the subject of the temporal clause included in Sentence Two, like in (6) and (8). The participants saw only one version of Sentence One (i.e., either example 6a or 6b for Italian; either example 8a or 8b for Swedish), so that the overt pronoun contained in Sentence Two referred either to the subject antecedent, like in (6a) and (8a) or to the object antecedent, like in (6b) and (8b). We asked the participants to read Sentence Two out loud, but not Sentence One, and to make clear to a listener, who the antecedent of the overt pronoun was, either *Riccardo* or *Diego* in (7), and either *Per* or *Martin* in (9).

(6) *Italian*

- a. Riccardo lavorava in una clinica privata.
Riccardo worked in a clinic private
‘Riccardo worked in a private clinic.’
- b. Diego lavorava in una clinica privata.
Diego worked in a clinic private
‘Diego worked in a private clinic.’

(7) *Italian*

- « Riccardo ha conosciuto Diego quando lui lavorava in una clinica privata. »
Riccardo has known Diego when he worked in a clinic private
‘Riccardo met Diego when he was working in a private clinic.’

(8) *Swedish*

- a. Per arbetade på en privatklinik.
Per worked for a private clinic
‘Per worked in a private clinic.’
- b. Martin arbetade på en privatklinik.
Martin worked for a private clinic
‘Martin worked in a private clinic.’

(9) *Swedish*

- « Per lärde känna Martin när han arbetade på en privatklinik. »
Per got know Martin when he worked for a private clinic
‘Per met Martin when he was working in a private clinic.’

Two lists were created in order to counterbalance the test items. In List 1, target items from 1 to 10 had a subject antecedent, like in (6a) and (8a), and items from 11 to 20 had an object antecedent, like in (6b) and (8b), while in List 2 target items from 1 to 10 had an

object antecedent, like in (6b) and (8b) and items from 11 to 20 had a subject antecedent, like in (6a) and (8a). Each participant saw only one version of the experiment, either List 1 or List 2 (see Supplementary file). Half of the participants were presented in List 1 and the other half in List 2. These two lists allowed us to avoid possible differences between the subject and the object condition, owing to the test items (e.g., phonetic context and length of the target sentence). Fillers consisted of two types of clauses: ambiguous relative clauses and anaphora containing antecedents with two different grammatical genders. We created the experiment in Italian, then translated it into Swedish.

5.2.2 The control interpretation task: Antecedent assignment in Italian and in Swedish

The control interpretation task was, for both groups, a binary forced-choice test, where the participants were visually presented with the same target sentences and fillers of the production task, but with different names (e.g., *Lorenzo* instead of *Riccardo*), to avoid a learning effect (see example 10a). The participants' task was to interpret globally ambiguous sentences as (10a), by answering a *who*-question as (10b). Two options were presented, i.e., to assign the pronoun either to the subject antecedent (*Lorenzo* in example 10c) or to the object antecedent (*Claudio* in example 10c). The participants were allowed to select only one answer for each sentence (either *Lorenzo* or *Claudio* in example 10c).

(10) *Italian*

- a. Lorenzo ha conosciuto Claudio quando lui lavorava in una clinica privata.
Lorenzo has known Claudio when he worked in a clinic private
'Lorenzo met Claudio when he was working in a private clinic.'
- b. Chi lavorava in una clinica privata?
who worked in a clinic private
'Who was working in a private clinic?'
- c. Lorenzo/Claudio

Both groups interpreted 40 sentences in total (20 target sentences and 20 fillers). The target sentences in Italian included both null and overt pronouns (10 sentences of each). In this case, we included null pronouns too because our aim was to ensure that the Italian participants conformed to the PAS (see RQ 2a and PRED 5). Similar to the production task, sentences were pseudo-randomized, and each target sentence was preceded and followed by a filler. Furthermore, sentences were counterbalanced only in the Italian control interpretation task. On the other hand, the target sentences in Swedish contained only overt pronouns (20 sentences).

5.2.3 The background questionnaire

Both groups completed the same background questionnaire, which included 24 questions. Two versions of the questionnaire were created, one in Italian and one in Swedish. The first question asked about the participants' age, two questions asked about education and employment, two more about their linguistic background (dialects and foreign languages), 14 about their language use and exposure, one about their parents' native languages, and four last questions inquired about places they had grown up and other countries they had lived. This questionnaire was included to attain a general profile of the participants, to ensure that they had not grown up in a bilingual environment and that they spoke their native language on a daily basis.

5.3 Procedure

After giving informed consent, the participants completed the background questionnaire, then the production task and, finally, the control interpretation task.⁵ For the production task, the sentences were presented on a computer screen (a 13-inch MacBook Pro), and recorded with a Zoom H4NPro Handy Recorder containing a built-in microphone. The recorder was fixed on a tripod and placed on a desk, next to the participants. The test was done in a quiet room and the participants were seated in a comfortable chair in front of the computer screen.

Before starting the production test, carried out with PsychoPy software (Peirce 2007), the participants were asked to read the instructions in their native language and an example of the experimental procedure was given. At this stage, they were encouraged to ask questions if something was unclear. The participants were informed that there was no correct answer, but only different possible interpretations of the task, and that they were allowed to repeat the same sentence out loud as many times as they needed, and we only analyzed the last repetition. A practice session of six sentences was performed to ensure that the task was clear.

Focusing on a cross placed at the center of the computer screen, the participants pressed the spacebar. At this point, Sentence One (i.e., the context sentence) appeared on the screen and, after two seconds, Sentence Two (i.e., the sentence of interest) appeared too. Both sentences remained on the screen until the participant was ready to proceed with the following test item, by pressing the spacebar. The participants were asked to only read Sentence Two out loud (i.e., the globally ambiguous sentence), which was presented in quotation marks, like in (7) and (9), and to address to a listener, who was seated at the other side of the desk, who could not see the computer screen and who did not know the situational context described in Sentence One.

The listener was one of the two experimenters: the Italian experimenter was the listener for the Italian group and the Swedish experimenter was the listener for the Swedish group. The presence of the listener was important to intensify the involvement of the participants in the task. We explained to the participants that the listener would be trying to understand what the antecedent of the globally ambiguous sentence was, but without providing any feedback. Furthermore, we explained to the participants that, since the presentation of the test items was randomized, the listener was not able to know in advance which version of the context sentence (Sentence One) was presented to each participant, either (6a) or (6b) for Italian, either (8a) or (8b) for Swedish. During the production test, the participants looked only at the computer screen and not at the listener.

After the production task, the participants completed the control interpretation task (see example 10), on printed paper. The task was to select either subject or object antecedents for each target sentence by ticking a box. There was no time limit for either of the experimental tasks (the production task and the control interpretation task).

5.4 Data analysis

For the production task, we collected 2240 target sentences in total from 56 participants, and we excluded sentences (143) that were not read correctly by participants, i.e., when a word was skipped, repeated, rephrased and misspelled or sentences where the division into segments of the target items (pronoun and subordinate conjunction) was not possible. Consequently, 2097 sentences were analyzed in total, 1069 from the 28 Italian speakers and 1028 from the 28 Swedish speakers.

⁵ All the three tests were anonymized.

The sound was analyzed in Praat (Boersma & Weenink 2018), by extracting, for each target sentence, the inter-clausal pause duration, the pronoun's duration, the subordinate conjunction's duration, the pronoun's mean intensity, the subordinate conjunction's mean intensity and the pronoun's list of pitch values. The data were then coded in Excel. Since the subordinate conjunction between the main and the temporal clause was not expected to be prosodically prominent in Italian or in Swedish, we used it as baseline to calculate the pronoun's relative length and the pronoun's relative intensity.

Specifically, for the duration of the inter-clausal pause (ms) we extracted the duration of the silent break between the last word of the main clause, i.e., the object, and the subordinate conjunction at the beginning of the subordinate clause. As shown in Figure 1, for the pronoun's relative length (%) we extracted the duration of the pronoun (Y), the duration of the subordinate conjunction (X) and obtained the duration of the whole segment containing subordinate conjunction and pronoun (X + Y), and then calculated the normalization for speech tempo with the formula $100 \cdot Y / (X + Y)$.

For the pronoun's average F0 range we extracted the list of pitch values (semitones re 100 Hz) of the pronoun (Y), from which we calculated the standard deviation (Figure 2). Consequently, we measured the tonal excursion of the pronoun but we did not look at the shape and timing of pitch accent on the pronoun. We focused on the pronoun's tonal excursion (i.e., the pronoun's F0 range) to avoid an interference of the temporal alignment of F0, which is significant for the specific types of lexical word accents in Swedish.

As shown in Figure 3, for the pronoun's relative intensity (dB) we measured the mean intensity of the pronoun (Y) and the mean intensity of the subordinate conjunction (X), then we calculated the normalization for intensity with the formula $Y - X$.

For the statistical analysis of the production data, we used linear mixed effects models in R (version 3.5.1, R core team 2018) with the packages lme4 (Bates, Maechler, Bolker & Walker 2015) and lmerTest (Kuznetsova, Brockhoff & Christensen 2017). Eight separate models were created, one for each outcome variable (i.e., the inter-clausal pause duration,

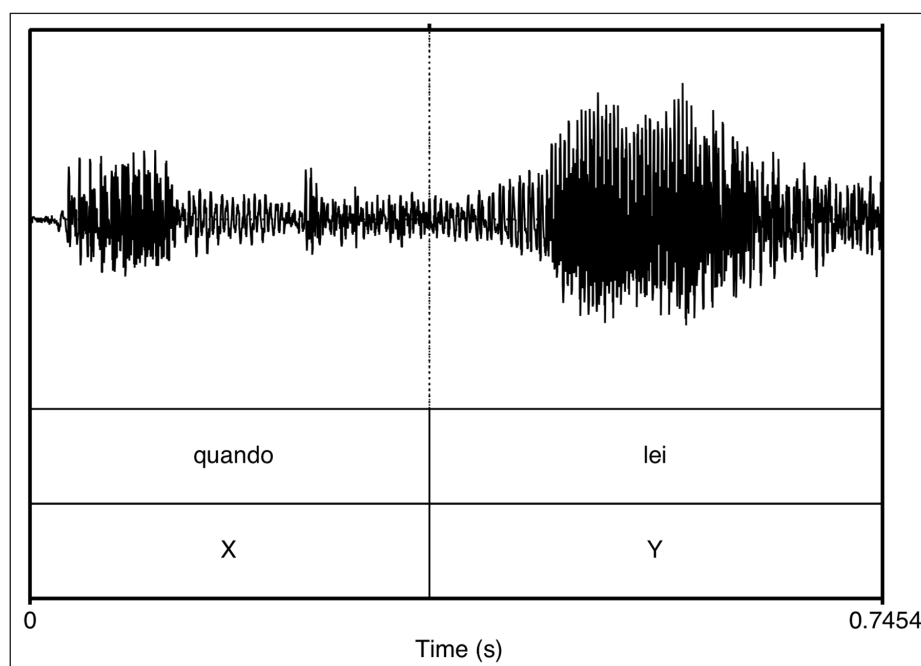


Figure 1: Segmentation of the subordinate conjunction *quando* 'when' (X) and the pronoun *lei* 'she' (Y) in an Italian target sentence, from Praat Picture.

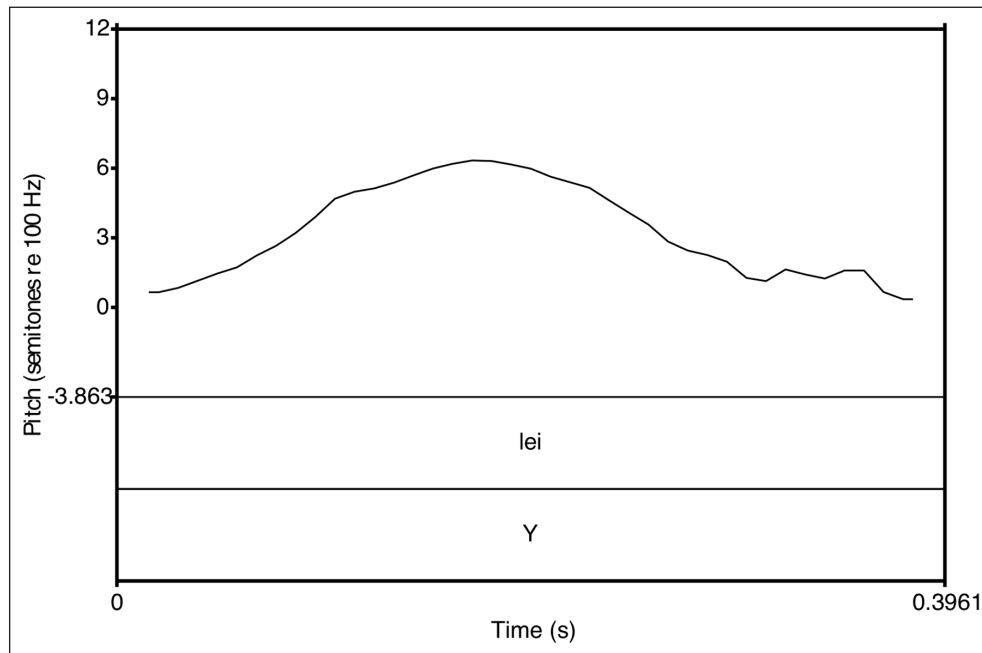


Figure 2: F0 movement of the pronoun *lei* ‘she’ (Y) in an Italian target sentence, from *Praat Picture*.

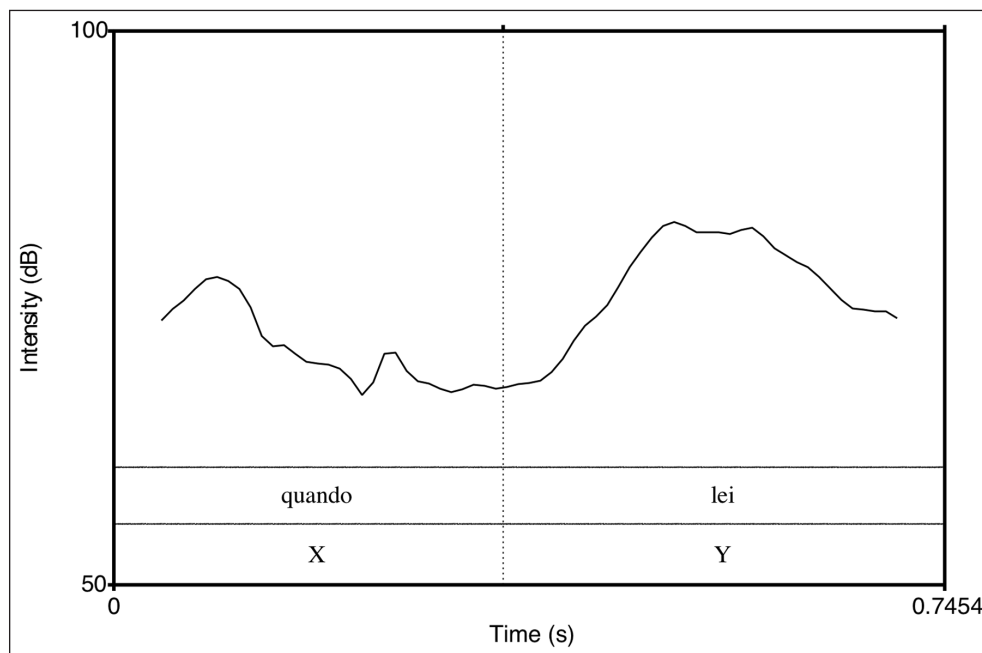


Figure 3: Intensity of the subordinate conjunction *quando* ‘when’ (X) and the pronoun *lei* ‘she’ (Y) in an Italian target sentence, from *Praat Picture*.

the pronoun’s relative length, the pronoun’s average F0 range, and the pronoun’s relative intensity) in each language (Italian and Swedish). In each model the antecedent (subject and object) was the fixed effect and participants were included as random effect.

For the control interpretation task, we collected 1120 sentences in total, 560 sentences from the Italian speakers and 560 sentences from the Swedish speakers. Both null and overt pronouns were included in the Italian control interpretation task, in order to ensure that the participants conformed to the PAS. On the other hand, only overt pronouns were included in the Swedish control interpretation task. Both groups selected what the

preferred antecedent of the pronoun was, either the subject or the object. We excluded sentences where both antecedents were selected, i.e., two sentences from one Swedish speaker.⁶ Consequently, we analyzed 560 sentences from the Italian group and 558 from the Swedish group. The data were coded in Excel, and for the analysis we used binary logistic mixed effects models with the lme4 package in R (Bates et al. 2015). Two separate analyses were done, one for the Italian group and one for the Swedish group. In the Italian model, pronoun and antecedent were the fixed effects and participants were included as random effect. In the Swedish model, we tested whether the preferred antecedent was selected above chance, i.e., above 50%, and participants were included as random effect.

6 Results

6.1 The production task

In the production task, we analyzed four outcome variables: the inter-clausal pause duration (i.e. the pause between the main clause and the subordinate clause), the pronoun's relative length (i.e. the pronoun's length normalized for speech tempo), the pronoun's relative intensity (i.e. the normalized intensity of the pronoun), and the pronoun's average F0 range (i.e. the standard deviation of the pronoun's pitch values). Table 2 shows the mean of each outcome variable, for subject and object antecedents, and the corresponding *p-value*.

First of all, as shown in Table 2, the mean of the inter-clausal pause duration in Italian was significantly larger for subject antecedents than for object antecedents, as expected (= PRED 1). Secondly, Table 2 shows also that the mean of the pronoun's relative length, the pronoun's average F0 range and the pronoun's relative intensity was significantly larger for Italian sentences with subject rather than object antecedents, suggesting that in Italian, subject antecedents elicit pronouns with a higher degree of prominence than object antecedents (= PRED 2). In Figure 4, the barplots show that this difference is clearer for the inter-clausal pause duration, the pronoun's average F0 range, and the pronoun's relative intensity, than for the pronoun's relative length.

Concerning the Swedish production data, contrary to our predictions on the inter-clausal pause duration (\neq PRED 3) and on the pronoun's degree of prominence (\neq PRED 4), the results in Table 2 suggest an unexpected difference between subject and object antecedents for three of the four acoustic measures. This is further illustrated in Figure 4. Specifically, the Swedish speakers show a larger pronoun's relative length, a larger pronoun's average F0 range, and less significantly, a longer pause duration when the antecedent corresponded to the object rather than to the subject. On the other hand, the

Table 2: Mean and *p-value* of the inter-clausal pause duration, the pronoun's relative length, the pronoun's average F0 range and the pronoun's relative intensity.

Measure	Italian			Swedish		
	subject	object	<i>p-value</i>	subject	object	<i>p-value</i>
Inter-clausal pause duration (ms)	105.61	80	0.000274***	70.87	87.86	0.0197*
Pronoun's relative length (%)	48.76	46.06	4.02e-09***	62.81	66.39	<2e-16***
Pronoun's average F0 range (st)	1.32	1.09	1.00e-06***	0.6	0.83	4.25e-16***
Pronoun's relative intensity (dB)	1.7	1.02	1.07e-11***	-0.09	-0.08	0.832

⁶ Five Swedish participants selected one response (either subject or object), as requested for this task, and added a comment, next to one or more target sentences, specifying that both responses were acceptable. Since the task was to select only one antecedent, which they did, we did not consider these comments.

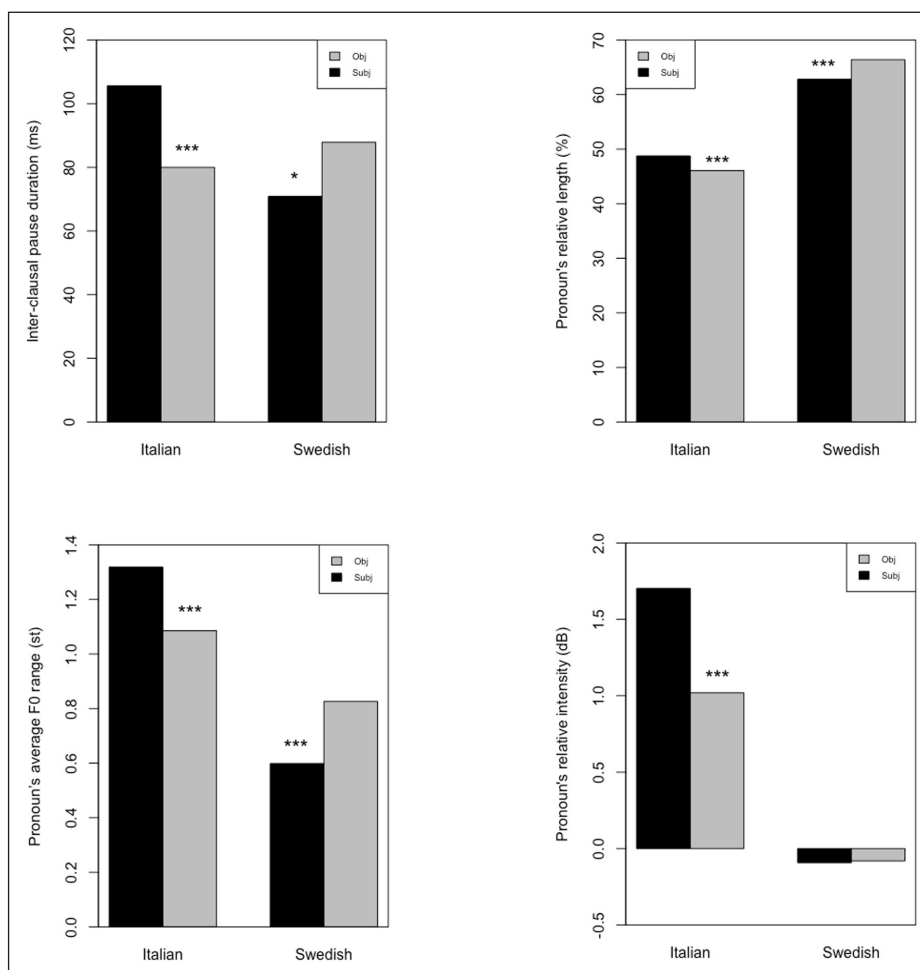


Figure 4: Mean of each acoustic measure for subject and object antecedents, in Italian and Swedish.

difference of the pronoun's relative intensity between subject and object antecedents was not significant in Swedish, as expected.

In summary, for the production task, the results show that the Italian speakers produced longer inter-clausal pauses and pronouns with a higher degree of prominence (in terms of relative length, average F0 range and relative intensity) when the antecedent corresponded to the subject rather than to the object. On the other hand, contrary to our predictions, the Swedish speakers produced longer inter-clausal pauses and pronouns with a higher degree of prominence (in terms of relative length and average F0 range but not relative intensity) when the antecedent corresponded to the object rather than to the subject.

6.2 The control interpretation task

The results of the control interpretation task show that the Italian group conformed to the PAS (= PRED 5), since they selected object antecedents for overt pronouns (the mean was 0.69) and also subject antecedents for null pronouns (the mean was 0.80). In fact, the assignment of subject and object antecedents was significantly predicted by pronoun type ($p < 2e-16$).

Concerning the Swedish control interpretation task, the data do not confirm our prediction for antecedent assignment (\neq PRED 6). We expected that the Swedish speakers would avoid having a preference for either subject or object antecedents in the control interpretation task, but this is not what we found. In fact, the Swedish participants significantly preferred subjects (the mean was 0.66) instead of objects (the mean was 0.34), as the

antecedents of overt pronouns. The subject antecedents were significantly selected above chance, i.e., above 50% ($p = 0.000192$).

In summary, these results suggest that the Italian speakers associated overt pronouns with object antecedents (and null pronouns with subject antecedents), while the Swedish speakers associated overt pronouns with subject antecedents.

7 Discussion

The present study explores how prosody interacts with pronoun resolution in Italian and in Swedish, and whether the way speakers use prosody reflects different preference patterns in antecedent assignment in the two languages.

First of all, we tested whether Italian speakers would produce a longer inter-clausal pause and a pronoun with a higher degree of prominence when the antecedent corresponded to the subject, i.e., the unpredictable antecedent, rather than to the object, i.e., the predictable antecedent (RQ 1a). In line with our predictions, the results showed that, when the pronoun referred to subject instead of object antecedents, the Italian speakers produced a longer inter-clausal pause (= PRED 1), and a pronoun with a higher degree of prominence (= PRED 2) for all three of the acoustic measures (i.e., the pronoun's relative length, the pronoun's average F0 range and the pronoun's relative intensity). This means that the Italian overt pronoun was longer, louder and had a wider tonal excursion when the antecedent corresponded to the subject rather than the object.

Secondly, we investigated whether Swedish speakers would avoid producing a longer inter-clausal pause and a pronoun with a higher degree of prominence in any of the two conditions, subject antecedent and object antecedent (RQ 1b). Contrary to our predictions, the Swedish speakers produced a longer inter-clausal pause (\neq PRED 3), and a pronoun with a higher degree of prominence (\neq PRED 4) when the pronoun referred to object rather than subject antecedents. Interestingly, two out of three of the acoustic parameters related to prominence were found to be significant in Swedish, the pronoun's relative length and the pronoun's average F0 range, but not the pronoun's relative intensity. This means that when referring to objects rather than subjects, the Swedish pronoun was longer and had a wider tonal excursion but it was not louder. Intensity was also found to be not significant in other studies on prosody and coreference (Rello & Llisterri 2012; Baumann & Roth 2014), but it is important to underline that the study by Rello & Llisterri (2012) focused on Spanish, and the study by Baumann & Roth (2014) focused on German and did not examine pronouns.

Thirdly, we explored whether the Italian speakers would associate overt pronouns with object antecedents and also null pronouns with subject antecedents, conforming to the PAS (RQ 2a). In line with our prediction, the Italian participants preferred object antecedents for overt pronouns, and also subject antecedents for null pronouns (= PRED 5). We then explored whether the Swedish speakers would avoid having a preference for either subject or object antecedents when they interpreted overt pronouns, reflecting the underlying ambiguity of pronoun resolution in this language (RQ 2b). Again, we found unexpected results for the Swedish group. The Swedish speakers showed a preference for subjects, because they more often associated overt pronouns with subject rather than object antecedents (\neq PRED 6). Despite these unexpected findings for the Swedish group, our main hypothesis is largely confirmed, but in a different way.

In light of our results, we can argue that the Italian and the Swedish speakers used pause and prosodic prominence to refer to different antecedents, and this reflected opposite patterns in antecedent assignment in the two languages (see Table 3). In fact, longer inter-clausal pauses and pronouns with a higher degree of prominence were produced for

Table 3: Summary of our results on overt pronoun resolution, compared to our predictions.

Object of analysis	Results				Predictions				Level of analysis	Experimental task
	Italian		Swedish		Italian		Swedish			
	sbj	obj	sbj	obj	sbj	obj	sbj	obj		
Inter-clausal pause duration & degree of prominence	>	<	<	>	>	<	=	=	Prosody	Production task
Antecedent assignment	-	+	+	-	-	+	=	=	Syntax-pragmatics	Control interpretation task

subject antecedents in Italian and for object antecedents in Swedish. At the same time, while the Italian speakers preferred to assign overt pronouns to object antecedents (and null pronouns to subject antecedents), the Swedish speakers preferred to assign overt pronouns to subject antecedents.

As we had predicted for Italian, pause and prosodic prominence broke the canonical patterns of antecedent assignment and favoured the unpredictable antecedent (see Goad et al. 2018). Unexpectedly, this was true also for the Swedish speakers. The Swedish speakers assigned overt pronouns to subject antecedents in the control interpretation task, while we had predicted that they would show ambiguity in antecedent assignment (PRED 6). As a consequence, they also presented an unexpected prosodic pattern, i.e., they produced longer pauses and pronouns with a higher degree of prominence in one of the two conditions, while we expected that they would avoid doing so (PRED 3 and 4, respectively).

The most reasonable explanation is that this unexpected preference for subjects as the antecedents of overt pronouns is related to the role of the subject in sentences like (2). In fact, in those sentences, the subject of the main clause represents the most prominent antecedent from different perspectives, which we describe below. The following explanation is based on Kawaguchi (2016).

First, the subject represents the most prominent item of a clause with respect to its grammatical function (Keenan & Comrie 1977). Secondly, the subject of our target sentences was in first position, the most prominent position (Choi 2001). This means that, when dealing with globally-ambiguous sentences, the Swedish speakers may have adopted a general strategy of assigning the pronoun to the most prominent antecedent in terms of its grammatical function and position. Consequently, the subject represented the most predictable antecedent of overt pronouns for the Swedish speakers because it corresponded to the most prominent antecedent. This strategy was also reflected in their use of prosody: the Swedish participants signalled that the pronoun referred to the object (the most unpredictable antecedent), by using prosodic features, such as longer pauses or a higher degree of prominence on pronouns.

On the other hand, the Italian participants did not assign an overt pronoun to the most prominent antecedent, the subject, because a null pronoun was preferred in those contexts. Italian speakers can, in fact, use two alternatives of the same linguistic structure, i.e., a null pronoun, which is generally associated with subject antecedents, and an overt pronoun, which is generally associated with object antecedents (Carminati 2002). These different preference patterns in antecedent assignment in the two languages affected the speakers' use of prosody because the unpredictable antecedent of an overt pronoun was the subject for the Italian speakers, and the object for the Swedish speakers.

8 Conclusion

The results of the present study suggest that the specific way Italian and Swedish speakers use prosody to resolve an anaphora reflects different preference patterns in antecedent assignment in the two languages. Inter-clausal pauses and pronouns' prosodic prominence favour the most unpredictable antecedent of overt pronouns in both languages. The most unpredictable antecedent of overt pronouns is the subject for Italian speakers and the object for Swedish speakers.

Some factors that were not part of the present study need further research. First, as explained above, we did not look at the shape and timing of pitch accent on the pronoun, but we focused on its F0 range, to avoid an interference of the temporal alignment of F0, which is significant for the specific types of lexical word accents in Swedish. Baumann & Roth (2014), for instance, found that both rising and falling tones were correlated with non-coreference (but rising tones more than falling tones). Secondly, further work is needed on the analysis of individual differences among the participants, which may shed light on the variation of the use of prosody in pronoun resolution. Thirdly, we considered adding the test item factor as a random effect in our statistical model; however, we did not do it because the context-sentence (Sentence One) was not the same for all participants, since sentences are counterbalanced across conditions. Finally, a control perception test is needed to further confirm our findings pertaining to the cross-linguistic difference between a null subject language and a non-null subject language, because the Goad et al. (2018) perception study focused on L1 and L2 Italian without looking at the baseline, i.e., the L1s of the group of L2ers.

Abbreviations

DAT = dative, obj = object, PAS = Position of Antecedent Strategy, pro = null pronoun, sbj = subject, SG = singular

Additional File

The additional file for this article can be found as follows:

- Supplement to *The role of prosody in overt pronoun resolution in a null subject language and in a non-null subject language: a production study*. DOI: <https://doi.org/10.5334/gjgl.973.s1>

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Competing Interests

The authors have no competing interests to declare.

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