

The processing of subject-verb agreement with postverbal subjects in Italian

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The processing of subject-verb number agreement has been extensively studied when the subject precedes the verb. By contrast, agreement processing in dependencies in which the subject follows the verb has been less investigated. To address this gap, we measured the processing of sentences with postverbal subjects in Italian adults, investigating the role of syntactic structure and discourse licensing on agreement processing. We tested whether number agreement violations in verb-subject orders were processed differently depending on whether they occurred in transitive structures with clitic-left dislocation vs. in unaccusative structures with locative inversion. Because transitive structures are temporarily ambiguous and more constrained by discourse conditions than unaccusative structures, we hypothesized that the former might increase comprehenders' memory load and impair the detection of agreement violations. The results of speeded acceptability judgments and self-paced reading tasks failed to support this hypothesis. However, transitive structures were accepted less often in isolation and elicited higher reading times than unaccusative structures, consistent with an increased cognitive load. We propose that the two structures are processed differently, but that this does not affect the computation of morphosyntactic relations like agreement. Instead, measures targeting interpretative processes – like discourse integration – may be more promising for future research.



1. Introduction

Sentence comprehension requires speakers to compute subject-verb agreement dependencies (Blackwell, 1996; Faussart et al., 1999; Kilborn, 1991; a.o.). It has been argued that agreement computations are affected by working memory, such that higher memory load may increase processing cost and impair the detection of agreement violations (McDonald, 2008a; Reifegerste et al., 2017). The role of memory has been examined in different ways. Some studies have considered speakers' memory span or working memory capacity (Almor et al., 2001; Blackwell & Bates, 1995; Bock & Cutting, 1992; Fayol et al., 1994; Hartsuiker & Barkhuysen, 2006; McDonald, 2006, 2008a, 2008b; Reifegerste et al., 2017, 2020). Other studies have considered sentence-internal factors that may affect the retrieval of information from memory and the processing of agreement dependencies (Jäger et al., 2017; Mertzen et al., 2024; Nicenboim et al., 2018; Van Dyke et al., 2014; Wagers et al., 2009).

With some exceptions, most previous studies have focused on syntactic structures in which the agreement controller – the grammatical subject – occupies a canonical position in the linear ordering of the sentence. In languages in which the subject canonically precedes the verb – like Italian, English or Spanish – this corresponds to a subject-verb configuration (SV). By contrast, agreement processing has been less studied in non-canonical configurations, such as those involving a verb-subject word order (Deutsch, 1998; Franck et al., 2006; Santesteban et al., 2013; Vigliocco & Nicol, 1998; Zawiszewski & Friederici, 2009).

To address this gap, our study targets the processing of number agreement in Italian structures with a verb-subject word order (VS). Italian offers an interesting case, because it allows for postverbal subjects with different verb classes. Here, we focus on transitive structures with clitic left-dislocation (henceforth OC_{lit} VS) vs. unaccusative structures exhibiting locative inversion, i.e., with a preverbal non-dislocated locative PP (henceforth, L_{oc} VS). These structures differ in ways that may potentially affect comprehenders' memory load and differentially influence the processing of subject-verb agreement. In particular, OC_{lit} VS are temporarily ambiguous with respect to the identification of the subject, while L_{oc} VS ones are not. Hence, OC_{lit} VS structures demand a more complex parsing.

Another difference is that OC_{lit} VS structures are constrained by specific discourse conditions, as they mark the preverbal object as topical. By contrast, L_{oc} VS structures are available in a broader range of discourse conditions, and hence are considered unmarked in their word order (see 1.3). Therefore, investigating agreement processing with Italian postverbal subjects can reveal whether the real-time computation of agreement relations is affected by the type of syntactic structure as well as the discourse constraints involved.

1.1. The role of memory in the processing of subject-verb agreement

A link between working memory demands and the processing of agreement dependencies has been proposed by McDonald (2008a), in order to account for the fact that – compared to other

morphosyntactic structures – agreement morphology is acquired later and is more error-prone in second language (L2) speakers (Goldschneider & DeKeyser, 2005; Paradis, 2005), as well as speakers with language impairments (Druks, 2006). McDonald (2008a) tested healthy adult native speakers with a grammaticality judgement task targeting several English structures. Memory load was manipulated between participants, such that half of the participants had to remember a list of seven digits during each trial, while the other half did not. Participants' accuracy in the higher memory load condition declined more significantly for subject-verb agreement than for other structures. The results paralleled those of previous studies using a similar paradigm in both comprehension (Blackwell & Bates, 1995; Hayiou-Thomas et al., 2004; McDonald, 2006) and production (Fayol et al., 1994; Hartsuiker & Barkhuysen, 2006). The outcome was interpreted as evidence that agreement dependencies are harder to process than other syntactic dependencies, and hence are more affected by reduced working memory capacity. This was proposed to explain their later acquisition and their higher susceptibility to errors, compared to other structures.

The impact of memory on agreement processing has also been investigated by considering individual measures of working memory capacity. This approach has been recently employed in studies investigating the effects of aging on sentence comprehension. Aging is often linked to a decline in working memory capacity (Carpenter et al., 1994; Kemtes & Kemper, 1997). Using a timed grammaticality judgment task and a self-paced reading task, Reifegerste et al. (2017) investigated how this affected adult German speakers' susceptibility to agreement attraction errors. They found that – compared to younger participants – older participants took longer to process agreement dependencies and were more likely to accept sentences with attraction errors. Among older participants, performance was modulated by working memory capacity, such that participants with lower working memory scores experienced greater processing difficulty and showed reduced accuracy compared to participants with higher scores.

The results of Reifegerste et al. (2017) were partially replicated in production. Reifegerste et al. (2020) tested agreement production in German L1 and L2 speakers across the adult lifespan, using a binary-choice sentence completion task. They found opposite effects of aging and memory capacity in the two groups of speakers. Accuracy decreased with increasing age among L1 speakers, but showed the opposite tendency among L2 speakers. Working memory capacity, instead, had no effect on the L1 group, but significantly modulated L2 speakers' performance. Mixed results in agreement production were also reported by Bock and Cutting (1992), who found an effect of individual working memory span on accuracy in only one of the three experiments in their study. By contrast, a strong correlation between working memory and accuracy has been found by Veenstra et al. (2017) in both monolingual and bilingual children, and by Slevc and Martin (2016) in patients with brain injuries.

Following the accounts of agreement processing mentioned above, one may predict that, given two different types of agreement dependencies, the one involving a higher memory load should impose greater processing difficulties, making agreement violations harder to detect.

In memory-based models of sentence comprehension (Baddeley, 1986; Gibson, 1998; Just & Carpenter, 1992; King & Just, 1991), memory load is linked to syntactic complexity. For example, sentences containing a filler-gap dependency as the result of a dislocation are thought to impose a greater load on working memory than sentences that can be parsed in a word-by-word fashion. This is often exemplified by the contrast between subject- and object-extracted relative clauses (e.g., *The banker that praised the barber climbed the mountain* vs. *The banker that the barber praised climbed the mountain*). Object-extracted relative clauses are considered harder to process, because the initial noun phrase (*the banker*) needs to be activated and retained in memory while the embedded clause is being processed, before being integrated with its verb phrase (*climbed the mountain*).

A large number of studies offer empirical evidence in support of the claim that more complex structures impose a higher load on memory (e.g., Gordon et al., 2001, 2002; Mak et al., 2002; Traxler et al., 2002, 2005). With respect to agreement computation, Franck et al. (2010) compared agreement error rates related to object relative clauses vs. complement clauses in French (**John spoke to the patients that the medicine cure* vs. **John tells the patients that the medicine cure*). Results showed that participants were more likely to produce agreement mistakes in the former configuration than in the latter. They interpreted the results in light of the fact that object relative clauses involve object movement, while complement clauses do not.

In addition to complexity, temporary ambiguity is also thought to generate demand for additional memory resources. In the capacity constrained parsing model (Just & Carpenter, 1992), the greater difficulty of processing temporarily ambiguous, as opposed to unambiguous, sentences is claimed to depend on the cognitive effort of activating and maintaining two (or more) alternative interpretations in memory until the disambiguation point is reached. MacDonald et al. (1992) advanced empirical evidence in support of this claim by analyzing word-by-word reading times of temporarily ambiguous sentences (*The soldiers warned about the danger before the midnight raid*) vs. unambiguous sentences (*The soldiers spoke about the danger before the midnight raid*). The former sentences induced higher reading times, consistent with the additional processing cost of generating multiple representations. The same results were replicated by Long and Prat (2008). In our study, we explore the possibility that the additional effort induced by temporary ambiguity is reflected in the processing of subject-verb agreement.

Summarizing, our study tests the hypothesis that $OC_{lit}VS$ structures in Italian may elicit higher processing costs compared to $L_{oc}VS$ structures. We base our prediction on the observation that $OC_{lit}VS$ structures involve a more complex parsing than $L_{oc}VS$ structures, primarily due to being temporarily ambiguous with respect to the identification of the subject (see 1.3). Thus, we hypothesized that number agreement violations may be harder to process in $OC_{lit}VS$ as compared to $L_{oc}VS$ structures. Crucially, this hypothesis would be impossible to test in sentences with a canonical subject-verb order.

1.2 The processing of agreement in sentences with non-canonical word orders

Few psycholinguistic studies – mostly on production – have examined subject-verb agreement in constructions displaying a non-canonical constituent ordering. These studies investigated whether word order affected speakers' computation of subject-verb agreement dependencies. For example, Vigliocco and Nicol (1998) compared error rates in declarative SV sentences vs. interrogative VS sentences in English (**The helicopter for the flights are safe* vs. **Are the helicopter for the flights safe?*). The results showed that participants produced the same amount of agreement errors in both configurations. The authors interpreted the outcome as evidence that agreement was not sensitive to word order variations (but see Franck et al., 2006, for different results in Italian). However, the two agreement dependencies differed in terms of linear proximity: in declarative sentences, the distractor intervenes between the controller and the target, while in interrogative sentences, it does not. Thus, the potential proximity advantage in interrogative sentences may be offset by an opposing factor – namely, that agreement computation is more challenging in non-canonical interrogative sentences than in canonical declarative sentences. Capitalizing on this possibility, Santesteban et al. (2013) explored agreement production in canonical SOV vs. non-canonical OSV sentences in Basque. They found that participants' agreement error rate increased significantly in non-canonical sentences, compared to canonical ones. The results were attributed to greater working memory demands in the OSV order, which limited the resources available for agreement computation.

More generally, previous studies have shown that non-canonical word orders are harder to process than canonical orders, likely due to greater syntactic complexity and infrequency in speech (Bader & Meng, 1999; Clahsen & Featherston, 1999; Hyönä & Hujanen, 1997; Imamura et al., 2016; Kaiser & Trueswell, 2004; Sekerina, 1997; Tamaoka et al., 2005, 2011). Moreover, non-canonical structures are licensed by particular discourse conditions, while canonical ones are more broadly available. In particular, both OSV sentences in Basque and the OVS sentences examined in our study are associated with an information structure in which the object is topicalized (see 1.3). Therefore, the presence of an object displaying features normally associated with the subject (e.g., first position; topicality) might interfere with the identification of the actual subject of the sentence (Badecker & Kumuniak, 2007; Hartsuiker et al., 2003; Thornton & McDonald, 2003). However, the study of Santesteban et al. (2013) considered non-canonical sentences in isolation, leaving open the question of whether the processing costs associated with discourse-marked structures can be mitigated by a licensing context (Bader & Meng, 2023; Brown et al., 2012; Burholt Kristensen et al., 2013, 2014; Clifton & Frazier, 2004; Erdocia et al., 2009; Hoeks et al., 2002; Kaiser & Trueswell, 2004; López-Beltrán et al., 2021; Mak et al., 2008; Roland et al., 2012; Slioussar, 2011; Stolterfoht, 2005; Torregrossa et al., 2024; Weskott et al., 2011; Yano & Koizumi, 2018).

Our study tests the hypotheses of Santesteban et al. (2013) about the higher working memory demands of non-canonical word orders in agreement comprehension in Italian. To do so, it compares two postverbal subject structures that differ with respect to their degree of canonicity (see 1.3). In doing that, it takes a step forward by analysing non-canonical structures within their appropriate discourse conditions (see Experiment 3).

1.3 Postverbal subjects in transitive vs. unaccusative structures in Italian

Italian is a pro-drop language with flexible word order. The canonical order is SVO, such that the subject precedes the verb, as in (1a) and (2a). However, structures with a postverbal subject are also possible in various configurations with all verb classes (Bates et al., 1982; Maiden, 1995; Rizzi, 1982; Vincent, 1990). Here we compare transitive structures with clitic left-dislocation (OC_{lit} VS) vs. unaccusative structures with locative inversion (L_{oc} VS). In OC_{lit} VS structures, the preverbal position is filled by a topicalized direct object, which is co-referential with a resumptive clitic in the main clause ('the dress' in (1b)).¹ In L_{oc} VS structures, the preverbal position is filled by a locative PP ('in the shop' in (2b)). In these structures, the locative constituent is not resumed by a clitic.²

- (1) a. Preverbal subject (transitive structure)
 Una signora osserva il vestito.
 a lady observe_{.PRS.3SG} the dress
 'A lady observes the dress.'
- b. Postverbal subject (transitive structure)
 Il vestito lo osserva una signora.
 the dress CLIT_{.ACC.M} observe_{.PRS.3SG} a lady
 'The dress, a lady observes it.'
- (2) a. Preverbal subject (unaccusative structure)
 Una signora entra nel negozio.
 a lady enter_{.PRS.3SG} in the shop
 'A lady enters the shop.'

¹ Occurrences of OVS order without a cliticized object are also attested in Italian, but are not considered in the present study. For a complete overview of possible word orders in Italian, see Lahousse and Lamiroy (2012).

² Locative PPs in Italian can also be left-dislocated with the use of the resumptive locative clitic *ci* (e.g., *nel negozio, ci entra una signora* 'Into the shop, a lady enters'). This configuration is different from locative inversion, because the locative PP functions as a left-peripheral topic in a topic-comment structure, similar to the direct object in OC_{lit} VS structures. On the difference between clitic left-dislocation and locative inversion with unaccusative verbs, see Cinque (1990) and Hoekstra and Mulder (1990).

b. Postverbal subject (unaccusative structure)

Nel negozio entra una signora.
 in the shop enter_{.PRS.3SG} a lady
 ‘A lady enters the shop.’

OC_{lit} VS and L_{oc} VS structures differ in several ways. One is related to temporary ambiguity. In OC_{lit} VS structures, the direct object *il vestito* ‘the dress’ in (1b) might be initially interpreted as the subject of the sentence, because it is in sentence-initial position and is a topic. By contrast, the locative *nel negozio* ‘in the shop’ in the L_{oc} VS structure (2b) cannot receive the same interpretation, because it is preceded by the preposition *nel* ‘in’. As observed by Franck et al. (2006) in French, the introduction of another potential controller for agreement might hinder agreement computations in OC_{lit} VS structures.

Moreover, temporary ambiguity may affect the parsing of the two structures. In OC_{lit} VS structures, the parser is forced to re-analyse the first constituent as the object upon encountering the clitic, and to establish a referential link between the two elements. Then, the dislocated object needs to be stored in memory before being integrated into the verb phrase after the verb is encountered. By contrast, in L_{oc} VS structures, the first element is unambiguously interpreted as a fronted adjunct before the verb is encountered. Furthermore, once the parser identifies the unaccusative verb, it can anticipate the occurrence of a postverbal subject, thus minimizing any potential surprise effect of encountering a verb before the subject. This results from the syntax of unaccusative verbs, according to which the grammatical subject is base-generated in postverbal position as an internal argument and behaves syntactically like a direct object (Belletti, 1988; Burzio, 1986; Koopman & Sportiche, 1991; Perlmutter, 1978). Based on these observations, it can be assumed that L_{oc} VS structures can be parsed in a more straightforward way and with a lower memory load compared to OC_{lit} VS structures.

Another difference is related to discourse conditions. OC_{lit} VS structures are licensed by stricter discourse conditions than L_{oc} VS structures, because they require the direct object to be informationally given – i.e., mentioned in the preceding discourse. For example, sentence (1b) could be an appropriate answer to a question that mentions the object, like “What about the dress?” or “Who’s observing the dress?”, as in (3). The resulting structure is a topic-focus configuration with an informationally-given object in preverbal position and an informationally-new subject in postverbal position (Arnold et al., 2000; Birner & Ward, 2009; Gundel, 1988; Vallduví, 1990; Ward & Birner, 2011).

(3) Q: Chi osserva il vestito? (‘Who’s observing the dress?’)

Il vestito lo osserva una signora.
 the dress CLIT_{.ACC.M} observe_{.PRS.3SG} a lady
 ‘The dress, a lady observes it.’

By contrast, L_{oc} VS structures are less dependent on a specific information structure. A sentence like (2b) can be licensed by a context analogous to (3) – i.e., as an answer to the question “Who is entering the shop?”. Crucially, however, the syntax of unaccusative verbs also allows for them to be licensed in sentence-focus conditions – i.e., when the entire sentence is informationally new and all elements are focal (Leonetti, 2018). Thus, (2b) would also be an appropriate answer to a broad-focus question like (4).

- (4) Q: Che succede? ('What happens?')
 Nel negozio entra una signora.
 in the shop enter_{.PRS.3SG} a lady
 'A lady enters the shop.'

Due to these facts, it is fair to assume that L_{oc} VS structures have a lesser degree of markedness compared to OC_{it} VS structures (see Adger, 1996; Belletti, 1988, 2018; Bentley & Cruschina, 2018; Cardinaletti, 2018; Pinto, 1994, 1997; Russi, 2014; for discussion). In both cases, the subject linearly occupies the postverbal position, but the fact that (2b) is licensed in sentence-focus conditions makes it a less marked – and more frequent – word order option. In contrast, (1b) is only licensed in narrow focus conditions and, hence, is a more marked – and less frequent – option (for frequency data about postverbal subject structures in Italian, see Bernini, 1995; Sornicola, 1994, 1995). Following Santesteban et al. (2013), we hypothesize that this asymmetry might affect the processing of agreement dependencies, with violations detected with greater difficulty in OC_{it} VS structures compared to L_{oc} VS structures.

Interestingly, the differences between the structures under investigation might explain some previous findings in first and second language acquisition. As for first language acquisition – although there are no studies directly comparing the two structures – data across studies point to the fact that Italian postverbal subjects may be mastered at different time points, depending on the type of syntactic structure. In production, Italian children between 18 and 36 months of age are shown to distinguish subjects of unaccusative verbs from those of other verb classes, and to appropriately produce them in postverbal position (Lorusso et al., 2005). By contrast, the production of postverbal subjects with transitive verbs and clitic left-dislocation – despite being comparable to that of adults in terms of number of occurrences – is characterized by the frequent omission of the resumptive clitic (Cairncross & Dal Pozzo, 2022; Lorusso, 2014, 2017). In comprehension, the study of Abbot-Smith and Serratrice (2015) shows that at age 4;6, children still misinterpret postverbal subjects with transitive verbs and clitic-left dislocation. Taken together, these findings suggest that Italian children may have greater difficulty mastering postverbal subjects in transitive structures than in unaccusative structures. Similar results have been found with L2 learners and bilingual speakers (Belletti et al., 2007; Belletti & Leonini, 2004; Bettoni et al., 2009; Caloi et al., 2018; Listanti & Torregrossa, 2023, 2024; Nuzzo, 2015).

Processing-based accounts of language acquisition (McDonald, 2008a) link differences in the timing of acquisition to varying working memory demands across linguistic phenomena. In this study, we test the hypothesis that such differences are reflected in varying processing difficulties in adulthood.

To summarize, OC_{lit} VS structures in Italian differ from L_{oc} VS structures on a number of dimensions, including potential temporary ambiguity, higher parsing complexity, stricter discourse licensing conditions and a different timing of acquisition. Since all these differences may result from a greater working memory load in OC_{lit} VS, we predicted that subject-verb number agreement would be harder to process in these structures compared to L_{oc} VS structures.

1.4 The present study

We measured adult Italian speakers' sensitivity to subject-verb number agreement violations in sentences with postverbal subjects. We conducted three experiments to examine whether the detection of these violations was different in OC_{lit} VS structures vs. L_{oc} VS structures. Experiments 1 and 2 presented target sentences in isolation, while Experiment 3 presented sentences preceded by a licensing context. The single-sentence presentation mode in Experiments 1 and 2 allowed us to focus on sentence-level processing, putting aside the sentences' pragmatic felicity and the potential contribution of discourse-integration processes. Experiment 3 addressed whether the results of Experiments 1 and 2 extended to situations in which postverbal subjects were discourse-licensed.

2. Experiment 1: Speeded grammaticality judgments

Experiment 1 examined whether Italian comprehenders judged sentences with postverbal subjects differently in L_{oc} VS structures vs. OC_{lit} VS structures. Target sentences were manipulated according to two factors: STRUCTURE (L_{oc} VS vs. OC_{lit} VS), and GRAMMATICALITY (grammatical vs. ungrammatical). Grammatical sentences had subject-verb dependencies agreeing in number, whereas ungrammatical sentences had subject-verb agreement violations. We recorded participants' acceptance rates and response times.

A separate set of sentences with preverbal subjects was included as control items. These sentences featured the same transitive and unaccusative verbs as the sentences with postverbal subjects. They were used to ensure that any potential differences in the critical items were due to their different licensing of postverbal subjects, rather than to uncontrolled differences between verb types (e.g., unaccusative and transitive verbs were necessarily different words and, thus, differed in lexical frequency, length, etc.).

We hypothesized that agreement violations would be harder to detect in OC_{lit} VS structures than in L_{oc} VS structures. Given our 2×2 design, this should result in a significant interaction

between structure and grammaticality, with a smaller difference of acceptance between the grammatical and ungrammatical conditions in OC_{lit} VS structures compared to L_{oc} VS structures. For response times, we assume that when agreement violations are processed with greater difficulty (in OC_{lit} VS structures), participants should reject the ungrammatical sentences more slowly than when agreement violations are computed more easily (in L_{oc} VS structures). However, since we expect that OC_{lit} VS structures will be harder to process than L_{oc} VS structures in the grammatical condition, too, we do not predict an interaction, but a main effect of structure (with longer overall response times for OC_{lit} VS structures than for L_{oc} VS structures). Crucially, if these effects were specifically due to the above mentioned differences between structures, they should be absent in the control items, which featured preverbal subjects.

2.1 Methods

2.1.1 Participants

Fifty-seven native speakers of Italian took part in the study. Participants were recruited through the online platform Prolific (www.prolific.com). In all experiments, participants were selected from different parts of Italy, with at least one participant from each of the twenty Italian regions. Participants provided informed consent and received monetary compensation. Before the experiment, they filled out a background questionnaire to determine that they had no history of language disorders and did not speak a language other than Italian from birth. One participant was excluded due to dysgraphia. The final sample of participants included 56 speakers (19 females; 51 right-handed; age range: 18–57 years). All participants reported having normal or corrected-to-normal vision. All procedures were in accordance with the Declaration of Helsinki.

2.1.2 Materials

The experimental stimuli were the same for the three experiments, except for minor modifications (see Appendix S1 in the Supplementary Materials). The stimuli consisted of 24 item sets that crossed the factors STRUCTURE (OC_{lit} VS / L_{oc} VS) and GRAMMATICALITY (grammatical / ungrammatical) – see example (5). In the target sentences, the verb and the postverbal subject were separated by an adverb. This intervening adverb was used to create an identical pre-critical region across conditions, since the verb region involved verbs with different number (singular or plural). The clitic-resumed direct object in the transitive condition was replaced by a locative PP in the unaccusative condition.³

³ With respect to prepositional phrases associated with Italian unaccusative verbs, some theoretical approaches distinguish between those that are clearly identifiable as adverbials and those that are arguably prepositional arguments of the verb (e.g., the goal of the verbs *arrivare* ‘to arrive’ and *partire* ‘to leave’; see Bentley & Cruschina, 2018). In this study, we did not control for this variable. Therefore, the monoargumental nature of some of our target sentences is debatable (see Appendix S1 in the Supplementary Materials for the full list of stimuli). Even if, according to such approaches, our unaccusative stimuli might not be considered structurally homogeneous, our choice was driven by the need to create enough material for the unaccusative condition.

All verbs were presented in the present tense and active form. For the identification of the unaccusative verbs, we relied on Levin et al. (1995) and Sorace (2000). All the unaccusative verbs used in the stimuli were checked by three different diagnostics of unaccusativity: the auxiliary selection test (Sorace, 2000), the *ne*-cliticization test (Belletti & Rizzi, 1981) and the participial absolute test (Loporcaro, 2003). Verbs were controlled for frequency using the SUBTLEX-IT corpus (<http://crr.ugent.be/subtlex-it/>). We report the mean frequency per million words of transitive and unaccusative verbs (transitives: $M = 148.62$, $SD = 201.55$; unaccusatives: $M = 154.14$, $SD = 198.53$). Both groups of verbs present a mean Zipf's value between 4 and 5 (transitives: 4.69; unaccusatives: 4.73), corresponding to a high level of frequency (van Heuven et al., 2014). This ensured that transitive and unaccusative verbs were comparable in terms of frequency. The length of the verbs (in characters) was also controlled for (transitives: $M = 8.17$, $SD = 1.63$; unaccusatives: $M = 7.63$, $SD = 1.13$). However, note that the critical effect of interest was the interaction between structure and grammaticality; thus, this effect cannot be attributed to lexical differences between transitive and unaccusative verbs, as the critical comparison is between the grammatical and ungrammatical conditions (within each structure).

Subjects and objects were treated uniformly in terms of definiteness: all objects were preceded by a definite article, and all subjects were preceded by an indefinite article. This was done because Italian postverbal subjects tend to be associated with new information (Belletti, 1998, 2004) and indefinite noun phrases are typically new in discourse (Clifton & Frazier, 2004). In $OC_{\text{lit}}VS$ structures, number and gender of the clitic object pronouns were also counterbalanced, so that $\frac{1}{4}$ of them were singular/masculine, $\frac{1}{4}$ were plural/masculine, $\frac{1}{4}$ were singular/feminine, and $\frac{1}{4}$ were plural/feminine. Half of the agreement violations occurred with singular verbs and plural subjects, and the other half with the reverse configuration.⁴

(5) **Sample item set with postverbal subjects (test items)**

- a. Transitive, grammatical
Il vestito lo osserva nel frattempo una signora.
- b. Transitive, ungrammatical
*Il vestito lo osservano nel frattempo una signora.
Translation: 'The dress, in the meantime a lady observes/*observe it.'
- c. Unaccusative, grammatical
Nel negozio entra nel frattempo una signora.
- d. Unaccusative, ungrammatical
*Nel negozio entrano nel frattempo una signora.
Translation: 'In the meantime a lady enters/*enter the shop.'

⁴ In exploratory analyses, no differences were observed depending on whether the violations occurred with plural vs. singular subjects. Therefore, the results report the analyses collapsed across this factor.

A separate set of control sentences was constructed using the same transitive and unaccusative verbs as in the test sentences. The control sentences differed from the experimental sentences in that they had preverbal subjects and different lexical items. Additionally, subjects in the control sentences were definite, for the same reason as they were indefinite in the experimental sentences: preverbal subjects tend to be associated with given information, and definite noun phrases are typically given in discourse. However, this does not represent an issue for comparability, because the two item sets were analysed separately and never directly compared in the statistical analyses. The control sentences were also manipulated for STRUCTURE and GRAMMATICALITY – see example (6). All items are available in the Supplementary Materials (Appendix S1).

(6) **Sample item set with preverbal subjects (control items)**

- a. Transitive, grammatical
L'amica finalmente visita l'Italia.
- b. Transitive, ungrammatical
*L'amica finalmente visitano l'Italia.
Translation: 'The friend finally visits/*visit Italy.'
- c. Unaccusative, grammatical
L'amica finalmente viene in Italia.
- d. Unaccusative, ungrammatical
*L'amica finalmente vengono in Italia.
Translation: 'The friend finally comes/*come to Italy.'

2.1.3 Procedure

Four Latin Square lists were created and distributed among participants, such that each participant saw only one version of each item (in both test and control items). 96 fillers and 4 practice items were added to each list, such that each list included 148 items in total. Half of the filler items were grammatical, while the other half contained different types of grammatical violations (e.g., lack of gender, wrong case assignment, omission of words or wrong word orders). Ungrammatical and grammatical sentences were presented in a 1:1 ratio. Experimental and filler items were presented in an order pseudorandomized by participant, such that no more than two items from the same condition appeared consecutively.

The experiment was implemented in IbexFarm (Drummond, 2013). Participants filled out a background questionnaire and were then presented with the instructions and practice items. All trials began with a blank screen with a double hyphen ('--') at its center. Upon pressing the spacebar, participants were presented with sentences word-by-word, with each word appearing at the center of the screen for 250 ms. After the sentence, a screen containing the question 'Is this sentence acceptable?', and two buttons with 'yes' and 'no' responses appeared. Participants

were instructed to answer by pressing a designated key: F for ‘yes’ and J for ‘no’.⁵ This prompt remained on the screen until participants made their judgment, or for a maximum of 2000 ms. The keys used to make responses were recorded. To verify participants’ engagement, 8 untimed attention checks were used. These sentences asked participants to press either the F or J keys. All participants passed all attention checks successfully.

2.1.4 Analysis

Responses that exceeded the response deadline or were below 200 ms were excluded from analysis (Lago et al., 2019; Staub, 2009). This resulted in the exclusion of 2.46% (test items) and 2.83% (control items) of trials. Judgment data were analyzed with a generalized linear mixed-effects model. Sentences judged as acceptable were coded as 1, sentences judged as unacceptable were coded as 0. Response times were analyzed with a linear mixed-effects model. Following the Box–Cox procedure (Box & Cox, 1964), response times were reciprocally transformed. Only trials with correct responses were included in the response time analysis (Wang et al., 2021).

The statistical models for the analysis of acceptability and response times included fixed effects of GRAMMATICALITY (grammatical vs. ungrammatical), STRUCTURE (OC_{lit} VS vs. I_{oc} VS), and their interaction. All fixed effects were sum-coded as -0.5 (grammatical; transitive) and $+0.5$ (ungrammatical; unaccusative). The maximally converging random-effects structure of each model was determined via backwards stepwise elimination, using the ‘buildmer’ package (Voeten, 2021) in R (R Core Team, 2021). After identifying the maximally converging model, *p*-values for all fixed effects were calculated, using the Satterthwaite approximation for denominator degrees of freedom (Kuznetsova et al., 2017). Figures and averages display untransformed measures for easier interpretability, but statistical analyses were always performed on transformed measures to meet model assumptions. The main text reports the effects that reached significance or were relevant for the research questions, but readers can access full model outputs in the Supplementary Materials (Appendix S2). Data, code and a full list of materials for this and the following experiments are available at <https://doi.org/10.17605/OSF.IO/CEY5W>.

2.2 Results

2.2.1 Sentences with postverbal subjects (test items)

Figure 1 shows descriptive summaries of acceptance rate and response times in items with postverbal subjects (test items). With regard to acceptance rates, participants accepted

⁵ Since the majority of the participants were right-handed, it is plausible to expect – all other things being equal – response times to be slower for ‘no’ than for ‘yes’, because the key J is on the right part of the keyboard and F is on the left. This might affect the interpretation of a main effect of grammaticality. However, the interaction between structure and grammaticality, which is our crucial effect of interest in the test items, remains interpretable.

grammatical sentences more often than ungrammatical sentences, resulting in a main effect of grammaticality ($\beta = -4.86$, $SE = 0.38$, $z = -12.74$, $p < .001$). Moreover, participants accepted OC_{lit} VS structures less often than L_{oc} VS, resulting in a main effect of structure ($\beta = -1.63$, $SE = 0.21$, $z = -7.76$, $p < .001$). Finally, the interaction between grammaticality and structure was not significant ($\beta = 0.35$, $SE = 0.42$, $z = 0.82$, $p = .41$).

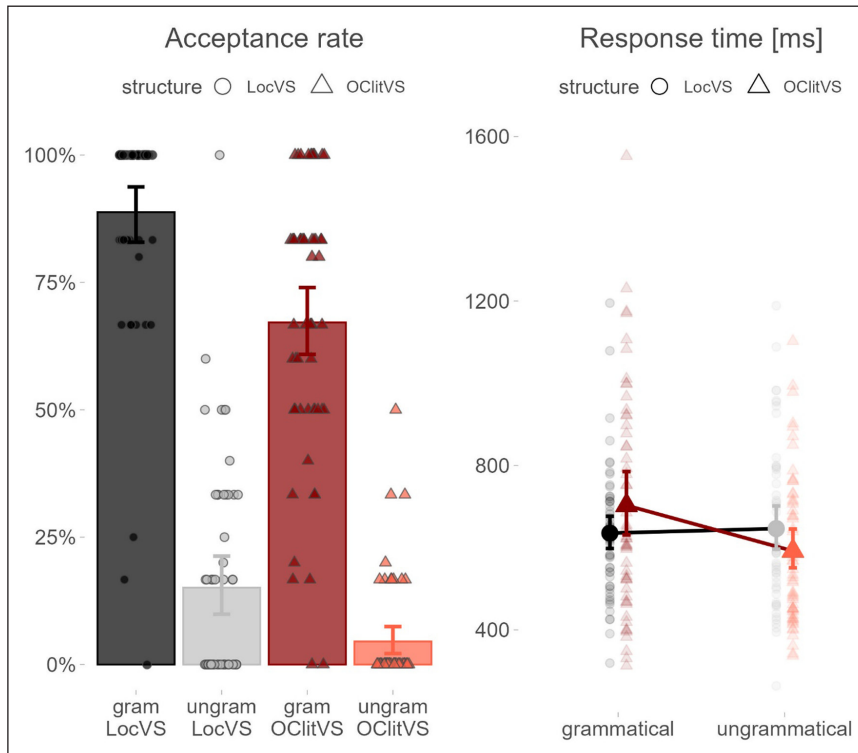


Figure 1: Empirical acceptance rates and response times for sentences with postverbal subjects in Experiment 1 (test items). Error bars show bootstrapped confidence intervals computed across participants and items. Each point represents one participant.

Response times showed a two-way interaction between structure and grammaticality ($\beta = -0.23$, $SE = 0.1$, $t = -2.28$, $p = .02$). Inspection of **Figure 1** (right panel) suggests that this was due to opposite effects of grammaticality in OC_{lit} VS structures vs. L_{oc} VS structures. However, pairwise comparisons did not reveal an effect of grammaticality in either OC_{lit} VS structures ($\beta = 0.14$, $SE = 0.09$, $t = 1.49$, $p = .14$) or L_{oc} VS structures ($\beta = -0.08$, $SE = 0.06$, $t = -1.24$, $p = .20$). In fact, the numeric trends suggested a stronger effect of grammaticality in transitive sentences than in unaccusative sentences. Thus, neither response times nor acceptance rates provided evidence that the detection of agreement violations was harder in OC_{lit} VS sentences than in L_{oc} VS sentences.

2.2.2 Sentences with preverbal subjects (control items)

Figure 2 shows descriptive summaries of acceptance rates and response times in the sentences with preverbal subjects (control items). As expected, acceptance rates only showed a main effect of grammaticality, with grammatical sentences being accepted more often than ungrammatical sentences ($\beta = -6.39$, $SE = 0.49$, $z = -13.07$, $p < .001$). Response times only showed a significant effect of grammaticality, with faster responses for ungrammatical sentences than for grammatical sentences ($\beta = 0.61$, $SE = 0.05$, $t = 11.54$, $p < .001$).

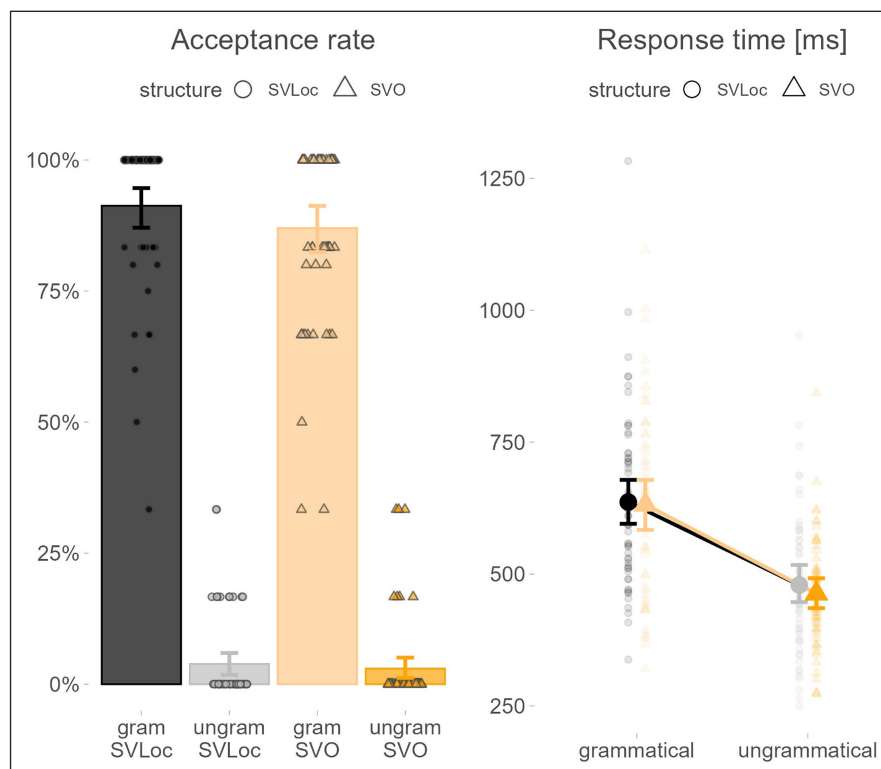


Figure 2: Empirical acceptance rates and response times for sentences with preverbal subjects in Experiment 1 (control items). Error bars show bootstrapped confidence intervals computed across participants and items. Each point represents one participant.

2.3 Discussion

We hypothesized that agreement violations with postverbal subjects would be harder to detect in OC_{lit} VS structures than in L_{oc} VS structures. The results of Experiment 1 failed to support this hypothesis, as acceptance rates did not show a significant interaction between grammaticality and structure. Participants clearly detected ungrammatical sentences, and there was also evidence that OC_{lit} VS structures were accepted less often than L_{oc} VS structures. But, crucially, there was no evidence that the detection of violations occurred less quickly or less often in OC_{lit} VS sentences

than in L_{oc} VS sentences. An interaction between grammaticality and structure did appear in response times, but the pairwise comparisons did not reach significance.

The lack of a significant interaction between structure and grammaticality in the test items is unlikely to result from lexical differences between the transitive and unaccusative verbs used. This is because the control items, which featured the same verbs but with preverbal definite subjects, showed the predicted main effect of grammaticality in the absence of any effects of structure or interactions. This suggests that, irrespective of structure, participants uniformly rejected ungrammatical sentences with preverbal subjects and were faster to judge them, compared to grammatical sentences. The latter outcome is in line with previous studies showing that if the unacceptability of a structure is evident, participants are faster to reject it than to accept its grammatical counterpart (De Vogelaer et al., 2020; Lago et al., 2019).

While the results of Experiment 1 fail to support an effect of type of structure in the detection of agreement violations with postverbal subjects, it could be argued that the judgment task only provided a coarse test of this hypothesis. This is because responses were collected only at the end of the sentence, rather than when postverbal subjects were encountered. Specifically, it is possible that the processing of postverbal subjects was initially harder in OC_{lit} VS structures, but that participants had overcome this difficulty by the end of the sentence, when their judgments were collected. To address this possibility, Experiment 2 used a self-paced reading design to measure processing difficulty time-locked to the appearance of postverbal subjects.

3. Experiment 2: Self-paced reading without context

Experiment 2 used items similar to Experiment 1, but recorded reading times while participants read the sentences word-by-word on a computer screen. The regions of interest were: (a) the region in which the agreement violations first became apparent; (b) the following region, because self-paced reading effects typically spill over (Lago et al., 2015; Parker & Phillips, 2016; Wagers et al., 2009). A set of test items is shown in (7). The critical regions are underlined. A set of control items is shown in (8). The regions created for analysis are shown with vertical bars, with their names indicated in italics.

(7) **Sample item set with postverbal subjects (test items)**

a. Transitive, grammatical

Il vestito | lo osserva | nel frattempo | una signora | dalla strada | di fronte.
topic verb pre-critical critical spillover wrap-up

b. Transitive, ungrammatical

*Il vestito | lo osservano | nel frattempo | una signora | dalla strada | di fronte.
topic verb pre-critical critical spillover wrap-up

Translation: ‘The dress, in the meantime a lady observes/*observe it from the front street.’

- c. Unaccusative, grammatical
 Nel negozio | entra | nel frattempo | una signora | dalla strada | di fronte.
topic verb pre-critical critical spillover wrap-up
- d. Unaccusative, ungrammatical
 *Nel negozio | entrano | nel frattempo | una signora | dalla strada | di fronte.
topic verb pre-critical critical spillover wrap-up
 Translation: 'In the shop a lady enters/*enter in the meantime from the front street.'

(8) **Sample item set with preverbal subjects (control items)**

- a. Transitive, grammatical
 L'attrice | ogni anno | visita | l'Italia | per una settimana.
topic pre-critical critical spillover wrap-up
- b. Transitive, ungrammatical
 *L'attrice | ogni anno | visitano | l'Italia | per una settimana.
topic pre-critical critical spillover wrap-up
 Translation: 'The actress every year visits/*visit Italy for a week.'
- c. Unaccusative, grammatical
 L'attrice | ogni anno | viene | in Italia | per una settimana.
topic pre-critical critical spillover wrap-up
- d. Unaccusative, ungrammatical
 *L'attrice | ogni anno | vengono | in Italia | per una settimana.
topic pre-critical critical spillover wrap-up
 Translation: 'The actress every year comes/*come to Italy for a week.'

We hypothesized that if OC_{lit} VS structures are harder to process than L_{oc} VS structures, participants should be less sensitive to grammatical violations in OC_{lit} VS structures. This should result in a significant interaction between structure and grammaticality in the regions of interest, with lower reading time disruptions in OC_{lit} VS structures than in L_{oc} VS structures. As for the control items, participants should react to agreement violations similarly, regardless of the structure, resulting in a main effect of grammaticality, but no interaction with structure in the regions of interest.

3.1 Methods

3.1.1 Participants

Two-hundred and eleven speakers of Italian took part in the study. One-hundred and four of them were recruited through the same procedure used in Experiment 1. One-hundred and seven of them were recruited among the students of the University for Foreigners of Siena in Italy, and received university credits for their participation. Exclusion criteria were similar to Experiment

1, resulting in the exclusion of bilingual participants ($n = 3$), participants with uncorrected vision ($n = 2$), dysgraphia ($n = 2$), participants whose mean reading time was more than 2 standard deviations away from the group mean ($n = 2$) and participants whose accuracy in the comprehension questions of filler items was below 90% ($n = 2$). The sample of participants whose data were analyzed included 200 speakers (133 females, 2 other; 185 right-handed; age range: 18–59).

3.1.2 Materials, procedure and analysis

The experimental stimuli used in Experiment 1 were modified to prevent postverbal subjects from appearing in a sentence-final position, which could give rise to wrap-up effects. With this goal, two prepositional phrases were added (see Appendix S1 in the Supplementary Materials). In test items, we analysed reading times at the subject (critical region) – the earliest point at which the agreement violations could be noticed – as well as at the word immediately afterwards (spillover region). In control items, one prepositional phrase was added at the end of the sentence, corresponding to the wrap-up region. We analysed reading times at the verb (critical region) – the earliest point at which the agreement violations could be noticed – as well as at the word immediately after (spillover region).

Four Latin Square lists were created, each of which included 48 experimental items, 54 fillers and 4 practice items, for a total of 106 items. All fillers were grammatical and had preverbal subjects. To ensure participants' engagement in the task and define exclusion criteria, comprehension questions based on true/false statements were included for a third of the experimental items and a third of the fillers. Onscreen feedback was provided for wrong answers only.

All trials began with a blank screen with a double hyphen ('--') at the center. When participants pressed a key on the keyboard, the first word of the target sentence appeared at the center of the screen. Participants read the target sentence one word at a time by pressing the spacebar. Each time the participants pressed the spacebar, a single word appeared at the center of the screen and the previous one was replaced. Reading times were measured for each word. If a comprehension question was included in the item, a screen containing the question and two buttons with 'yes' and 'no' responses appeared at the end of the sentence. Participants were instructed to answer by pressing a designated key (F for 'yes' and J for 'no'). This prompt remained on the screen until participants made their judgment.

Reading times below 200 ms or above 4000 ms were excluded (Chiuchiù & Benati, 2020; Shoghi et al., 2022). In test items, this excluded 3.6% of the data in the postverbal subject region and 2.6% of the data in the spillover region. In control items, this excluded 4.4% of the data in the verb region and 3.1% in the spillover region. After trimming, reading times were averaged across all words within a region. Following the Box–Cox procedure, which was performed on the reading

times in the regions of interest, a reciprocal transformation was used (1000/reading time). Due to the transformation, the coefficient of an estimated effect is more easily interpretable in terms of speed, rather than an absolute reading time difference. For example, a negative coefficient for the effect of grammaticality reflects reduced speed in ungrammatical, as opposed to grammatical, conditions (and, thus, longer reading times in ungrammatical conditions). Conversely, a positive coefficient would reflect increased speed (and, thus, shorter reading times).

Reciprocally-transformed RTs in the regions of interest were analyzed jointly, using REGION as a fixed effect (Cunnings & Sturt, 2018, Lago et al., 2021). This procedure helps minimize the number of statistical tests per region, it allows one to evaluate potential timecourse differences between regions, and it increases the ability to observe small effects that may be non-significant at individual regions but, nevertheless, consistent across them.

Reading times were analyzed with a linear mixed-effects model with fixed effects REGION (critical vs. spillover), STRUCTURE (OC_{lit} VS vs. L_{oc} VS) and GRAMMATICALITY (grammatical vs. ungrammatical), as well as their interaction. Fixed effects were sum-coded as -0.5 (grammatical, OC_{lit} VS, critical) and 0.5 (ungrammatical, L_{oc} VS, spillover). As in Experiment 1, the random-effects structure of the model was determined using backwards stepwise elimination.

3.2 Results

3.2.1 Sentences with postverbal subjects (test items)

Figure 3 shows a descriptive summary of the reading times in items with postverbal subjects (test items). The results in the combined critical and spillover regions showed a main effect of grammaticality, with longer reading times in ungrammatical sentences than in grammatical sentences: ($\beta = -0.09$, $SE = 0.02$, $t = -5.05$, $p < .001$). The predicted interaction between structure and grammaticality failed to reach significance ($\beta = 0.04$, $SE = 0.02$, $t = 1.56$, $p = .12$).

3.2.2 Sentences with preverbal subjects (control items)

Figure 4 shows a descriptive summary of the reading times in items with preverbal subjects (control items). The results showed a main effect of grammaticality, with longer reading times in ungrammatical sentences than in grammatical sentences ($\beta = -0.18$, $SE = 0.02$, $t = -9.2$, $p < .001$). There was also a main effect of region, with longer reading times in the spillover region than in the critical region ($\beta = -0.08$, $SE = 0.02$, $t = -5.1$, $p < .001$).⁶ Finally, there was an interaction between grammaticality and region ($\beta = -0.17$, $SE = 0.03$, $t = -6.2$, $p < .001$).

⁶ This effect differs from the visual patterns in Figure 4, which suggest faster reading times in the spillover region than in the critical region. The divergence is due to the fact that Figure 4 displays averages of untransformed reading times: when reading times were reciprocally transformed, the model estimates showed longer reading times in the spillover region.

The interaction was due to a larger grammaticality effect in the spillover region ($\beta = -0.26$, $SE = 0.02$, $t = -13.22$, $p < .001$) than in the critical region ($\beta = -0.09$, $SE = 0.02$, $t = -4.44$, $p < .001$). Crucially, no significant interaction between structure and grammaticality was found.

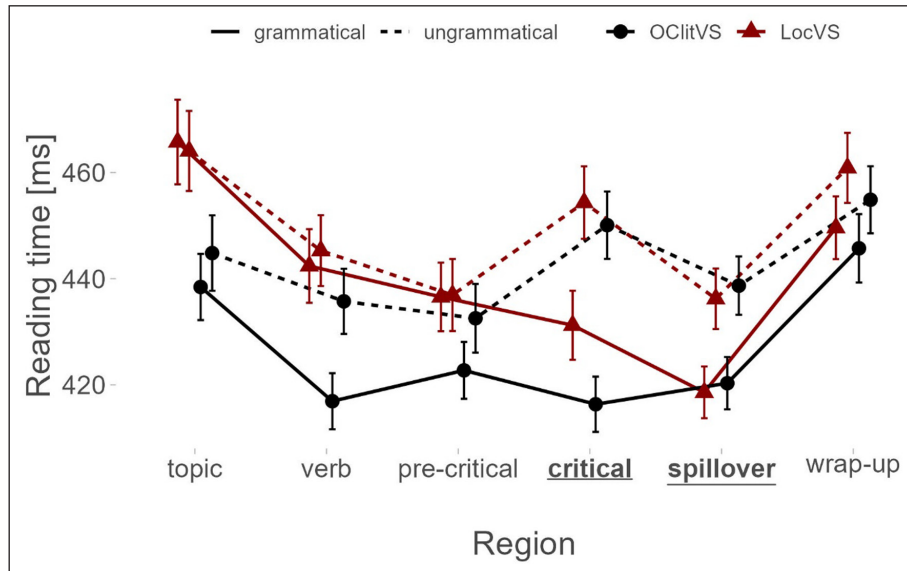


Figure 3: Participants' reading patterns in sentences with postverbal subjects in Experiment 2 (test items). Error bars show ± 1 standard errors averaged across participants and items.

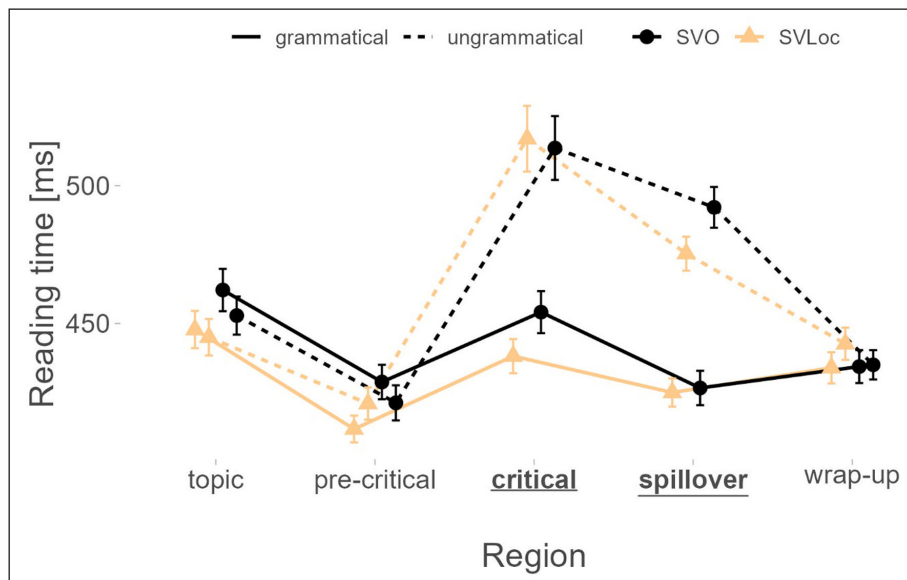


Figure 4: Participants' reading patterns in sentences with preverbal subjects in Experiment 2 (control items). Error bars show ± 1 standard errors averaged across participants and items.

3.3 Discussion

The results of Experiment 2 showed that Italian participants successfully detected subject-verb agreement violations, and that their sensitivity emerged immediately at the point of the disagreeing element. However, and consistent with Experiment 1, there was no evidence that sensitivity to violations decreased in OC_{lit} VS structures, an outcome expected under the hypothesis that OC_{lit} VS structures elicit higher cognitive load and are, therefore, harder to process than L_{oc} VS structures.

An unexpected result was that the grammatical and ungrammatical conditions in OC_{lit} VS structures seemed to differ at the verb region, where no difference was expected, as the sentence only became ungrammatical at the point of the subject phrase. This outcome emerges from a visual inspection of the plot, as no statistical analysis was performed in the verb region. The source of this early difference was unclear, and we do not currently have an explanation for it. It should be noted, however, that the difference was reduced at the pre-critical region, as signaled by the overlapping error bars. Therefore, we think it unlikely that the early divergence at the verb significantly distorted the patterns at the critical region.

One potential concern about Experiment 2 is that the sentences with postverbal subjects were presented out of context. This was done to maximize processing difficulty and enhance our ability to detect the modulatory effects of syntactic factors. However, it is important to acknowledge that this resulted in a non-naturalistic set-up for conducting a reading task. This is because it is known that the interpretation of discourse-marked word orders (as in the case of OC_{lit} VS structures) strongly depends on having an appropriate context (Bader & Meng, 2023; Brown et al., 2012; Burholt Kristensen et al., 2013, 2014; Clifton & Frazier, 2004; Erdocia et al., 2009; Hoeks et al., 2002; Kaiser & Trueswell, 2004; López-Beltrán et al., 2021; Mak et al., 2008; Roland et al., 2012; Slioussar, 2011; Stolterfoht, 2005; Weskott et al., 2011; Yano & Koizumi, 2018).

For example, Kaiser and Trueswell (2004) investigated the effects of information structure on the processing of canonical SVO sentences and non-canonical OVS sentences in a self-paced reading experiment in Finnish. OVS order in Finnish is licensed when the object is discourse-given and the subject is discourse-new. Half of the target sentences were preceded by a supportive context sentence eliciting these discourse conditions, while the other half were preceded by an unsupportive context. In the unsupportive condition, canonical sentences were read significantly faster than non-canonical sentences. In the supportive condition, these differences were significantly reduced. These results were used to argue that the processing differences between canonical and non-canonical structures in previous studies were due to the fact that the discourse conditions licensing non-canonical structures had not been met.

To examine whether the results of Experiment 2 generalized to cases in which non-canonical sentences were discourse-licensed, we re-ran Experiment 2, but added a context sentence before the critical sentence. The context sentence was used to elicit supportive discourse conditions for the use of postverbal subjects in OC_{lit} VS structures.

4. Experiment 3: Self-paced reading with context

4.1 Methods

4.1.1 Participants

109 native speakers of Italian took part in the study. All of them were recruited through the online platform Prolific and received monetary compensation for their participation. Exclusion criteria were the same as in Experiment 2, with participants being excluded because their mean reading times were more than 3 SDs below the group mean ($n = 4$) or because their comprehension question accuracy in the filler items was below 90% ($n = 9$). The final sample of participants included 96 speakers (40 females, 1 other; 87 right-handed; age range: 18–59).⁷

4.1.2 Materials, procedure and analysis

The same experimental, control and filler items from Experiment 2 were used, except that we added a context sentence before each target sentence (see (9) and (10)). In each item, the context sentence was the same for OC_{lit} VS and L_{oc} VS structures. The first noun phrase of the target sentence – the locative PP in the L_{oc} VS structure and the direct object in the OC_{lit} VS structure – was always mentioned in the context sentence. This way, the appropriate discourse conditions for the use of a postverbal subject in the target sentence were met. When necessary, target sentences from Experiment 1 and 2 were adapted in order to increase coherence with the context sentence (see Appendix S1 in the Supplementary Materials).

(9) Sample item set with postverbal subjects

Context Francesca prova il vestito da sposa in un negozio.

‘Francesca tries on the wedding dress in a shop.’

OC_{lit} VS Il vestito lo osserva/*osservano nel frattempo una signora dalla strada di fronte.

‘The dress, in the meantime a lady observes/*observe it from the front street.’

L_{oc} VS Nel negozio entra/*entrano nel frattempo una signora dalla strada di fronte.

‘In the shop a lady enters/*enter in the meantime from the front street.’

⁷ Experiment 3 was originally conducted as two separate experiments investigating whether the preverbal object in OC_{lit} VS structures could potentially trigger agreement attraction effects (Lago et al., 2015, 2021; Nicol et al., 1997; Wagers et al., 2009). In the first sub-experiment (Experiment 3a), object and verb number was counterbalanced across items and conditions. Specifically, half of the items displayed number match in the grammatical condition and number mismatch in the ungrammatical condition, while the other half displayed the opposite configuration. In the second sub-experiment (Experiment 3b), objects and verbs always mismatched in number in OC_{lit} VS grammatical structures, while they always matched in number in OC_{lit} VS ungrammatical structures. Both experiments exhibited similar patterns, and no attraction effects were detected. Thus, we collapsed across experiments in the analysis in order to maximize statistical power. A detailed comparison of the outcomes of the two sub-experiments is available in the Supplementary Materials (Appendix S3).

(10) **Sample item set with preverbal subjects (control items)**

Context	Roberta abbraccia un'amica all'aeroporto. 'Roberta hugs an actress at the airport.'
SVO	L'amica ogni anno visita/*visitano l'Italia per una settimana. 'The friend every year visits/*visit Italy for a week.'
SVL _{oc}	L'amica ogni anno viene/*vengono in Italia per una settimana. 'The friend every year comes/*come to Italy for a week.'

To avoid a lengthy experiment, context sentences were added to only half of the fillers. Comprehension questions were distributed such that, in experimental items, half of the questions were about the context sentence and the other half were about the target sentence. In the fillers, half of the questions targeted items without context, and the other half were distributed among context sentences and non-context sentences.

The procedure was the same as in Experiment 2, except that at the beginning of each trial, the context sentence (if present) appeared on screen. After reading the context sentence, participants read the target sentence one word at a time, as in Experiment 2. The analysis followed Experiment 2, with 2.86% of the data being removed in the critical region and 1.96% in the spillover region for test items. For control items, exclusions were 4.77% and 2.63%, respectively.

4.2 Results

4.2.1 Sentences with postverbal subjects (test items)

Figure 5 shows a descriptive summary of the reading times in sentences with postverbal subjects (test items). There was a main effect of grammaticality ($\beta = -0.08$, $SE = 0.02$, $t = -3.28$, $p < .005$), indicating longer reading times in ungrammatical conditions. There was also a main effect of structure ($\beta = 0.1$, $SE = 0.03$, $t = 3.49$, $p < .001$), indicating longer reading times in OC_{hit} VS structures than in L_{oc} VS structures. There was also a main effect of region, indicating longer reading times in the spillover region vs. the critical region ($\beta = -0.08$, $SE = 0.02$, $t = -3.87$, $p < .001$).

As in previous experiments, the interaction between grammaticality and structure was not significant ($\beta = -0.04$, $SE = 0.05$, $t = -0.73$, $p = .47$). However, visual inspection of **Figure 5** suggested a larger effect of grammaticality in the critical region for L_{oc} VS structures as opposed to OC_{hit} VS structures. We followed up on this observation by running an exploratory analysis and found that the effect of grammaticality was significant in L_{oc} VS structures ($\beta = -0.14$, $SE = 0.04$, $t = -3.47$, $p < .001$), but not in OC_{hit} VS structures ($\beta = -0.06$, $SE = 0.04$, $t = -1.4$, $p = .16$).

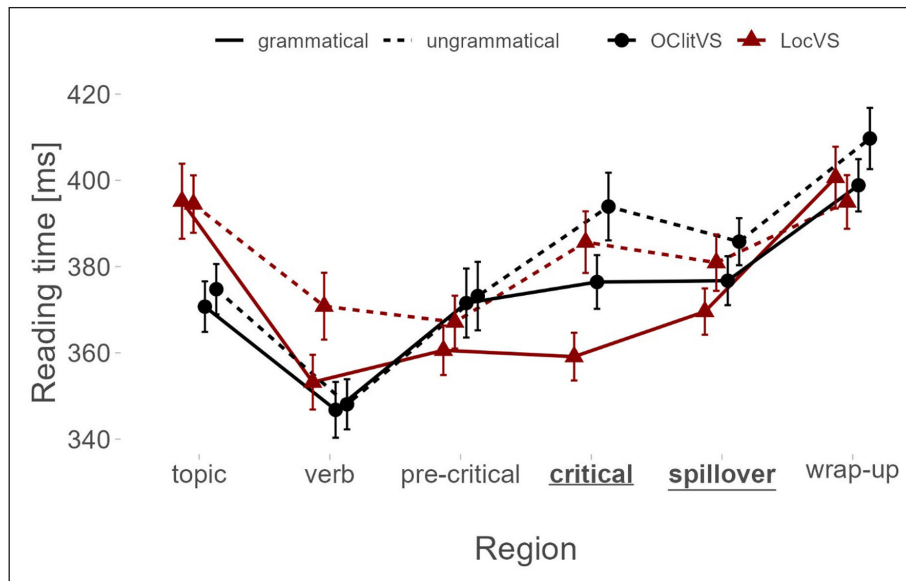


Figure 5: Participants' reading patterns in sentences with postverbal subjects in Experiment 3 (test items). Error bars show ± 1 standard errors averaged across participants and items.

4.2.2 Sentences with preverbal subjects (control items)

Figure 6 shows a descriptive summary of the reading times in sentences with preverbal subjects (control items). There was a main effect of grammaticality ($\beta = -0.15$, $SE = 0.03$, $t = -5.17$, $p < .001$), indicating longer reading times in ungrammatical conditions than in grammatical conditions, and a main effect of region ($\beta = -0.27$, $SE = 0.02$, $t = -12.37$, $p < .001$) indicating longer reading times in the spillover region than in the critical region. There was also an interaction between grammaticality and region ($\beta = -0.24$, $SE = 0.04$, $t = -5.64$, $p < .001$). Pairwise comparisons indicated that the effect of grammaticality was significant in the spillover region ($\beta = -0.27$, $SE = 0.03$, $t = -9.09$, $p < .001$), but not in the critical region ($\beta = -0.04$, $SE = 0.03$, $t = -1.17$, $p = .24$).

4.3 Discussion

The results of Experiment 3 replicated those of Experiment 2, with a few exceptions. First, $OC_{lit}VS$ structures were read significantly more slowly than $L_{oc}VS$ structures. This effect was surprising, because we expected a licensing context to facilitate the reading of $OC_{lit}VS$ structures. Second, pairwise comparisons at the critical subject region revealed a significant effect of grammaticality in $L_{oc}VS$ structures, but not in $OC_{lit}VS$ structures. This second result is consistent with the hypothesis that agreement violations might be harder to detect in $OC_{lit}VS$ structures, due to these structures being more complex and, thus, eliciting higher memory load. However, the pairwise comparisons were not supported by an interaction between grammaticality and structure, which

is the appropriate statistical test for our hypothesis. Due to the lack of a significant interaction and the fact that Experiment 3 had fewer participants than Experiment 2 (and, thus, less statistical power), we do not view the results as strong support for the hypothesis that the processing of agreement in sentences with postverbal subjects (within an appropriate context) is modulated by the type of structure involved.

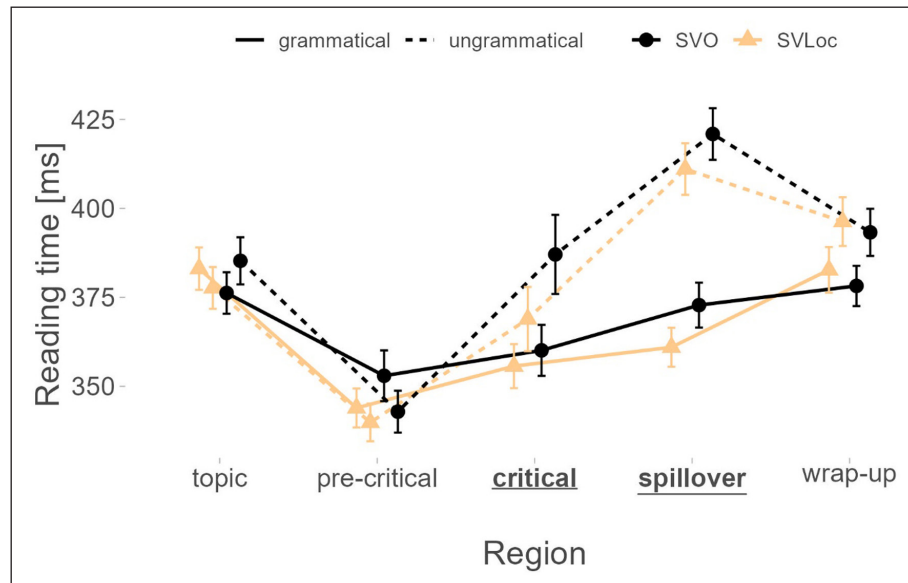


Figure 6: Participants' reading patterns in sentences with preverbal subjects in Experiment 3 (control items). Error bars show ± 1 standard errors averaged across participants and items.

As in Experiment 2, an unexpected result was that the grammatical and ungrammatical conditions seemed to differ at the verb region in sentences with postverbal subjects, this time with unaccusative verbs. This is unexpected, because the sentence only became ungrammatical at the subject. However, the difference seems to disappear at the pre-critical region, so we think it is unlikely to affect our comparisons at the critical subject region.

5. General discussion

Our experiments tested whether different structures with postverbal subjects in Italian affected the processing of subject-verb number agreement. We compared transitive structures with a clitic left-dislocated object (OC_{lit} VS) with unaccusative structures displaying locative inversion (L_{oc} VS). We hypothesized that the detection of agreement violations would be harder in OC_{lit} VS structures, because they are temporarily ambiguous, harder to parse and licensed by stricter discourse conditions. We hypothesized that these properties would increase participants' memory load

with OC_{lit} VS structures, which could impair their detection of agreement violations (McDonald, 2008b; Reifegerste et al., 2017, 2020). We examined whether this resulted in a significant interaction between structure and grammaticality in participants' judgments (Experiment 1) and/or reading times of the postverbal subject and following region (Experiments 2 and 3). In what follows, we discuss our results, integrate our findings with previous studies and outline limitations and future directions for research.

5.1 No evidence that the type of structure affects the detection of agreement violations with postverbal subjects

Our results failed to support the prediction that agreement violations would be harder to detect in OC_{lit} VS structures than in L_{oc} VS structures. Experiment 1 failed to show the predicted interaction between structure and grammaticality in acceptance rates, and the response times actually showed an interaction in the opposite direction. Experiments 2 and 3 also failed to show the predicted interaction in the reading times of the postverbal subject and the spillover region.

The only evidence consistent with our prediction was in the pairwise comparisons of Experiment 3, which revealed a significant effect of grammaticality at the point of the postverbal subject in L_{oc} VS structures, but not in OC_{lit} VS structures. But the pairwise comparisons cannot be taken as conclusive, given that they were not replicated in Experiment 2 (which had a larger participant sample) and that they were not supported by a significant interaction – which is the appropriate statistical diagnostic of our prediction (for discussion of the need for interactions to support claims about asymmetric effects, see Gelman & Stern, 2006; Nieuwenhuis et al., 2011). Therefore, the combined results of the three experiments did not yield evidence of a modulatory effect of the type of structure on the detection of agreement with postverbal subjects.

Our findings do not align with those of Santesteban et al. (2013) about agreement production in OSV and SOV sentences in Basque. However, it is important to note that Santesteban et al. (2013) compared canonical sentences with non-canonical ones. By contrast – although one of the two structures is considered less marked than the other – the subject phrase in both structures in our study occupied a position different from the one considered canonical in Italian (i.e., the preverbal position). Therefore, it is possible that the effect of a higher memory load associated with OC_{lit} VS structures was masked by the overall difficulty of processing agreement in postverbal subject configurations. Some evidence in support of this explanation comes from the comparison of agreement processing patterns in sentences with postverbal subjects vs. preverbal subjects. In the judgment task (Experiment 1), the average acceptance rate of sentences with agreement violations was lower with preverbal subjects than with postverbal subjects in both structure types: transitives: 3% vs. 4.5%; unaccusatives: 3.9% vs. 15%. In the reading tasks (Experiments 2 and 3), sentences with violations elicited longer reading times as soon as the incorrect agreement marking was encountered – consistent with processing disruption. However, the mean reading

disruption was higher with preverbal subjects than with postverbal subjects (Experiment 2: 67 ms vs. 28 ms; Experiment 3: 49 ms vs. 22 ms). These findings suggest that – regardless of syntactic structure – Italian adults’ ability to detect agreement violations is less robust in non-canonical postverbal subject structures than in canonical preverbal subject structures.

The results with preverbal subjects replicate the high sensitivity to agreement violations previously demonstrated in behavioral measures and brain responses in Italian (Biondo et al., 2018; De Vincenzi et al., 2003; Mancini et al., 2014) and other languages (Lago et al., 2021; Mancini et al., 2011; Pearlmutter et al., 1999; Reifegerste et al., 2017; Severens et al., 2008), and they show that our participants were performing the experiments attentively.

One explanation for our results is that some of the differences between the two structures under investigation were not strong enough to affect the processing of agreement. With respect to the syntactic differences, it should be noted that some Italian dialects allow for the use of left-dislocated locative PPs without a resumptive clitic (Benincà & Poletto, 2007; Ledgeway, 2009; Loporcaro, 2009). Such structures are superficially identical to the L_{oc} VS structures used in our experiments. Nevertheless, they involve a topical left-dislocated constituent like the OC_{lit} VS structures. Hence, it is possible that some of the participants interpreted L_{oc} VS structures as left dislocations and not as locative inversions, especially in Experiment 3, where the context sentence makes the preverbal constituent topical. Future research could address this possibility by comparing the processing of preverbal locatives with and without a resumptive clitic. Finally, regarding the temporary ambiguity in OC_{lit} VS structures, it is important to note that all our stimuli featured inanimate objects, which may have decreased the probability of their being interpreted as subjects, thereby reducing overall ambiguity.

5.2 General effects of type of structure on the processing of postverbal subjects

While there was no evidence that the type of structure differentially affected the detection of agreement violations, some of our findings do suggest that the OC_{lit} VS and L_{oc} VS structures elicit differential processing effort. In Experiment 1, we found a main effect of structure in the acceptance rates of sentences with postverbal subjects. The outcome was due to the fact that OC_{lit} VS structures were accepted significantly less often than L_{oc} VS structures. Interestingly, the difference emerged only in the grammatical sentences, while ungrammatical sentences were identified accurately regardless of structure type. We speculate that this might be explained by the fact that in Experiment 1, the sentences were presented in isolation. L_{oc} VS structures are felicitous in sentence-focus conditions, while OC_{lit} VS structures are only licensed if the preverbal object is informationally-given. Therefore, OC_{lit} VS structures are more sensitive to contextual constraints and, hence, should be less acceptable in isolation. Thus, the lower acceptability of grammatical sentences may be explained by the fact that the discourse requirements for the use of OC_{lit} VS structures were not met in Experiment 1.

Meanwhile, $OC_{lit}VS$ structures elicited significantly longer reading times than $L_{oc}VS$ structures when preceded by a licensing context (Experiment 3), but not when the context was absent (Experiment 2). The outcome is at odds with the expectation that the processing of informationally-marked sentences is facilitated by appropriate discourse conditions. Instead, our results point to the possibility that the integration of contextual information is associated with greater processing effort in comparison to marked sentences without context. From this standpoint, the longer reading times associated with $OC_{lit}VS$ structures in Experiment 3 might indicate that participants spent more time integrating the target sentences with the preceding context to construct an appropriate interpretation. A possible cause may be that the establishment of a reference for the clitic pronoun in the target sentence was initially unsuccessful: participants may have first failed to find a referent in the context sentence before realizing that it is co-referential with the topicalized object. This hypothesis requires further investigation.

Taken together, our results suggest that, independently of their grammaticality, $OC_{lit}VS$ structures require an appropriate context to be comprehended and accepted (Experiment 1), but that the presence of a context may increase their processing cost online (Experiment 3). In this respect, our results appear to be in line with previous studies showing that a supportive context helps global comprehension of non-canonical structures, but it does not necessarily affect online measures, such as reading times (Bornkessel & Schlesewsky, 2006; Burholt Kristensen et al., 2014).

5.3 Limitations and future directions

While our results do not support the hypothesis that the type of structure – $OC_{lit}VS$ vs. $L_{oc}VS$ – modulates the processing of agreement with postverbal subjects, some limitations should be acknowledged before this conclusion can be taken at face value. First, we cannot rule out the possibility that evidence of such sensitivity would have emerged if other processing paradigms had been used, such as brain-related potentials or reading eye-tracking (Dillon et al., 2013; Jäger et al., 2020; Pearlmutter et al., 1999; Schlesewsky et al., 2003; Yano & Koizumi, 2018; Zawiszewski & Friederici, 2009). For example, previous reading eye-tracking studies have reported that regressive eye movements are a key indicator of sensitivity to agreement violations (Dillon et al., 2013; Jäger et al., 2020; Pearlmutter et al., 1999). Since the self-paced reading paradigm does not allow readers to regress to previous material, our task may have lacked the sensitivity to detect differences between structures with transitive and unaccusative verbs.

Second, we may have lacked the statistical power to detect agreement processing differences between $OC_{lit}VS$ and $L_{oc}VS$ structures. Recent recommendations suggest that samples of around 110 participants are needed to detect a 2×2 medium-size interaction in within-subject designs (Brysbaert, 2019). Of our three experiments, only Experiment 2 met this threshold (200 participants), while Experiments 1 and 3 had fewer participants (56 and 96, respectively).

To address this possibility, we collapsed the two self-paced reading experiments (Experiments 2 and 3) and conducted a statistical analysis on the combined data (Appendix S4). The combined dataset included 296 participants and 1.776 observations per condition, which is considered adequate to detect a 2×2 interaction with an effect size identified as medium (Brysbaert & Stevens, 2018). In line with the single-experiment analyses, our combined analysis did not yield a significant two-way interaction between grammaticality and structure in the critical regions of interest. Thus, although we cannot rule out the possibility that our effect of interest might emerge with a larger number of observations, it seems reasonable to conclude that if such an effect exists, it is relatively small, requiring more than 296 participants to be detected in a self-paced reading task like ours.

In sum, although our main prediction was not borne out, some of our results suggest that transitive and unaccusative structures with postverbal subjects in Italian may elicit a differential processing cost. Specifically, the processing difficulty associated with one structure vs. the other might not affect agreement morphosyntactic computations, but it might disrupt other processes, such as discourse integration and thematic role assignment. If this were the case, measures directly targeting the interpretation of OC_{it} VS vs. L_{oc} VS structures may be more successful than agreement processing in detecting processing differences between them. We believe that this is a productive avenue for future research.

6. Conclusion

Our study investigated the role of structure type as a potential factor in the processing of agreement with Italian postverbal subjects. We focused on transitive structures with clitic left-dislocation and unaccusative structures with locative inversion. Our research question was driven by the observation of several differences between these structures. These include previous findings on the acquisition of Italian postverbal subjects in different learner populations, which have shown differential acquisition patterns related to the two structures. We hypothesized that this acquisition asymmetry could be reflected in a differential processing behavior among adult first language speakers. In particular, we predicted that noticing agreement violations would be harder with clitic left-dislocation. Although our results did not support this hypothesis, other processing differences suggest that the link between acquisition and processing is worth investigating further, for example, by means of different processing diagnostics and/or more temporally fine-grained experimental methods.

Abbreviations

ACC = accusative, M = masculine, PRS = present, 3SG = third person singular.

Data accessibility statement

Data, code and all materials for all the experiments are available at <https://doi.org/10.17605/OSF.IO/CEY5W>.

Additional file

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

- **Supporting Information.** Appendix S1 to S4. DOI: <https://doi.org/10.5070/G601146996.s1>

Ethics and consent

The studies involving human participants were performed in accordance with the 1964 Declaration of Helsinki and its later amendments, and the procedures were reviewed and approved by the Ethikkommission der Deutschen Gesellschaft für Sprachwissenschaft. All participants provided informed consent to participate in the studies.

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Competing interests

The authors have no competing interests to declare.

Authors' contributions

Andrea Listanti: conceptualization, data curation, formal analysis (main), funding acquisition, investigation, methodology, writing – original draft, writing – review & editing. **Sol Lago:** conceptualization, methodology, formal analysis (supporting), project administration, supervision, writing – review & editing. **Jacopo Torregrossa:** conceptualization, methodology, project administration, supervision, writing – review & editing.

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