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THE CHALLENGE OF VARIABILITY FOR SYNTACTIC ACCOUNTS OF AGRAMMATISM: A STUDY ON FEATURE DISSIMILARITY IN ITALIAN RELATIVES

This study explores syntactic processing in ten Italian-speaking individuals with agrammatism, testing predictions from two competing linguistic accounts: the Trace Deletion Hypothesis and Generalized Minimality. We examined subject, object, and passive relatives in comprehension (sentence-to-picture matching task) and production (sentence priming task), manipulating number mismatch as a possible facilitation factor. According to Generalized Minimality, mismatch should reduce intervention effects in object relatives, while the Trace Deletion Hypothesis predicts uniform impairment of derived structures. Comprehension results showed an overall subject advantage, with mismatch-related facilitation observed in a subset of participants. However, high interindividual variability challenged strong generalisations. No clear performance pattern emerged in production, possibly due to concurring deficits and task-related limitations. Passive relatives, expected to be easier in line with studies on language acquisition, were as impaired as object relatives, supporting a specific deficit with passives in agrammatism. Linguistic theory played a central role in accounting for the variability observed, with Generalized Minimality emerging as the most explanatory, yet not unchallenged account.

Keywords: aphasia; agrammatism; relative clauses; morphosyntax; relativized minimality; language assessment; syntactic movement; trace deletion hypothesis; sentence comprehension; sentence production.

1. INTRODUCTION

Agrammatism, a possible symptom of aphasia, is characterized by nonfluent speech with short utterances and frequent omissions of morphological elements. Since Caramazza and Zurif's (1976) seminal paper, it has been shown that individuals with agrammatism also display specific comprehension difficulties, especially with noncanonical reversible sentences, supporting the idea that agrammatism constitutes a robust clinical construct (e.g., Grodzinsky, 2000).

Theoretical linguistics has greatly advanced the study of agrammatism, aiming to identify the source of the deficit. In this context, sentences with relative clauses have been a critical structure,

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examined by several studies across languages. The present study aims at comparing two generative linguistic accounts of agrammatism by investigating the comprehension and production of relatives in Italian-speaking individuals with post-stroke agrammatism.

1.1 The Trace Deletion Hypothesis

Grodzinsky (2000) proposed the Trace Deletion Hypothesis, which claims that individuals with agrammatism cannot represent traces of syntactic movement. In object relatives, such as in (1), the deletion of the trace disrupts the ability to represent the dependency between the moved constituent and its original position, where the thematic role is assigned.

(1) John watches the cat_i that the dog chases t_i

As a consequence, people with agrammatism rely on an extra-syntactic agent-first strategy for interpretation. In (1), since the trace is not represented, the Agent thematic role is assigned both to 'the cat', following the agent-first strategy, and to 'the dog', since it is in the standard subject position.[20] As a result, people with agrammatism are expected to perform at chance in comprehension, since both DPs equally compete for the Agent role. Conversely, in subject relatives, such as in (2), the trace is also deleted, but no difficulty arises in thematic role assignment: the moved constituent and its trace are contiguous, and the agent-first strategy converges with the standard syntactic processing.

(2) John watches the dog_i that t_i chases the cat

The Trace Deletion Hypothesis can thus be defined as a structural account and, assuming a representational deficit, yields deterministic predictions about agrammatic performance.

1.2 The Generalized Minimality account

Different studies have criticised this structural account, as it cannot explain the wide variability observed in agrammatic performance and its correlation with other cognitive resources, particularly short-term memory (e.g., Caplan et al., 2007).

Grillo (2008) proposed an alternative hypothesis, called Generalized Minimality, to account for both the variability and the regularities found in agrammatism. According to Grillo, the underlying cause of morphosyntactic deficits in aphasia is a reduction in cognitive resources, which triggers a Feature Underspecification. This is defined as an impoverished representation of the full array of

[20] According to the Trace Deletion Hypothesis, the movement of the subject from Spec,VP to Spec,IP (Koopman & Sportiche, 1991) is not considered problematic for people with agrammatism.

morphosyntactic features associated with syntactic categories, and, in combination with the locality restrictions of syntactic representation, it accounts for the asymmetries observed in agrammatic production and comprehension.

Relativized Minimality (e.g., Rizzi, 2018) is the key locality constraint for this account, as it captures the idea that syntactic relations are disrupted if there is a suitable intervener. Here follows a formal definition of the principle:

> In [. . . X . . . Z . . . Y . . .] a dependency between X and Y is disrupted when
> (i) Z intervenes in the dependency between X and Y (i.e., X c-commands Z and Z c-commands Y), and
> (ii) Z matches X in terms of relevant syntactic features.[21]
> (iii) The degree of disruption is a function of the featural distinctness of X with respect to Z.

In subject relatives, such as in (2), no syntactic category intervenes in the dependency between the head of the relative and its trace. However, in object relatives, such as in (1), the subject DP of the relative clause structurally intervenes in the dependency. In adult unimpaired processing, this intervention does not trigger a minimality effect because the head of the relative and the intervening DP differ in their featural configuration: the head bears a wh-feature that triggers movement. In agrammatism, however, Feature Underspecification may lead to the loss of the wh-feature, resulting in identical featural configurations between the head and the intervener. This triggers a minimality effect and causes impaired performance.

As noted above, Feature Underspecification is defined as a deficit linked to limited processing resources. Since resource availability varies not only across but also within individuals (e.g., due to fatigue, attentional fluctuations, or cognitive load), the occurrence and degree of underspecification may fluctuate accordingly. This account thus better explains performance variability than strictly structural hypotheses such as the Trace Deletion Hypothesis. At the same time, Generalized Minimality captures the structural selectivity of the linguistic impairment, since underspecification leads to deficits only in specific syntactic contexts constrained by locality conditions, unlike purely processing-based accounts (e.g., Caplan et al., 2007).

A key property of this account is that it predicts that dissimilarities in morphosyntactic features between the two DPs in object relatives, such as grammatical number in (3), can provide a facilitation.

(3) John watches the cat_i that the dogs chase t_i

[21] Syntactic features are defined as relevant if they define syntactic positions, by licensing applications of External and Internal Merge (e.g., features involved in argument-verb agreement, triggers of movement to functional positions, etc.).

Indeed, even in cases of wh-feature underspecification, the DPs 'the cat' and 'the dogs' present distinct featural configurations, one being singular and the other being plural.

1.3 Experimental evidence

The comprehension asymmetry between subject and object relatives has been found in people with agrammatic aphasia across languages: English (see Grodzinsky, 2000 for a review), German (Adelt et al., 2017, 2020), Greek (Varlokosta et al., 2014), Hebrew (Friedmann, 2008), Italian (Grillo, 2008; Gilardone et al., 2023), Russian (Friedmann et al., 2010), and Serbo-Croatian (Lukatela et al., 1995).

Moreover, studies on language acquisition have reported robust evidence for a facilitation effect induced by feature dissimilarities between the head of the relative and the intervener (Belletti et al., 2012; Adani et al., 2010). As for agrammatism, results are more mixed. Friedmann and colleagues (2010) found no facilitation for gender and case features in Russian. Terzi and Nanousi (2018) observed a facilitation for gender mismatch in Greek, though notably also in subject relatives, which do not involve intervention. Adelt and colleagues (2017, 2020) found that, in German, case marking provides a better facilitation in comparison with number marking, as it provides earlier disambiguation within the sentence. Hence, they concluded that people with aphasia require a high degree of feature dissimilarity to successfully process structures characterised by intervention.

To address the controversy surrounding previous findings, this study is the first to investigate the comprehension and production of subject and object relatives in Italian agrammatic speakers, focusing on the unexplored facilitation effect of number dissimilarity. In particular, the Trace Deletion Hypothesis predicts a selective impairment in object relative clauses, with no effect of number-feature mismatch between the two DPs in the sentence. In contrast, Generalized Minimality also expects increased difficulty with object relatives, but crucially predicts a modulation of performance, whereby grammatical number mismatch yields a facilitation effect.

2. METHODS

The study was conducted at the Department of Neurorehabilitation Sciences, Casa di Cura IGEA in Milan (Italy). The protocol was approved by the local ethics committee (Milan Area 2; Resolution: 743_2022bis). All participants gave their informed consent in a manner appropriate to their abilities.

2.1 Participants

Ten participants were selected from the medical records of the clinic according to these criteria. Inclusion criteria: ischemic or haemorrhagic focal brain injury in the left hemisphere, right-handedness, chronic phase (time post-onset > 12 months), nonfluent aphasia with agrammatism, and Italian as native language. Exclusion criteria: neurodegenerative diseases, non-linguistic cognitive impairments, and affective or psychiatric disorders.

The characteristics of the participants are reported in Table 1. Neuroimaging data were not available, and information regarding lesion sites was retrieved from medical records.

The experimental protocol was also administered to a control group of 20 native Italian speakers with no history of neurological or psychiatric conditions, nor of language or learning disorders. Control participants were recruited among the relatives of individuals with aphasia and the clinical staff, and were matched to the aphasic group for gender, age, and educational level.

Table 1. Characteristics of the participants.

ID	**Sex**	**Age** *years*	**Ed.** *years*	**Hand.**	**Aetiology**	**Lesion site**	**TPO** *month*
I01	F	68	9	R	IS - MCA occlusion	LH - cortical (fronto-temporal)	132
I02	F	55	13	R	IS - MCA occlusion	LH - cortical and subcortical (fronto-insular, nucleo-capsular)	164
I03	M	48	17	R	IS - MCA occlusion	LH - cortical (fronto-temporal)	146
I04	F	52	17	R	IS - MCA occlusion	LH - cortical (fronto-temporal)	123
I05	F	75	16	R	IS - cardioembolic	LH - cortical and subcortical (fronto-temporo-insular)	43
I06	F	71	8	R	IS - cardioembolic	LH - cortical and subcortical (fronto-temporal)	79
I07	M	51	18	R	IS - MCA occlusion	LH - cortical and subcortical (frontal and nucleo-capsular)	32
I08	F	54	17	R	IS - ICA dissection	LH - cortical (fronto-temporo-parietal)	76
I09	F	60	13	R	IS - MCA occlusion	LH - cortical (fronto-temporo-parietal)	155
I10	F	65	18	R	IS - ICA dissection	LH - cortical (fronto-temporo-parietal)	73

Notes. M=male; F=female; R=right-handed; IS=Ischemic stroke; MCA=Middle Cerebral Artery; ICA=Internal Carotid Artery; LH=Left Hemisphere; TPO=Time Post-Onset.

2.2 Standardised aphasia assessment

Each participant underwent standardised assessment of language and verbal short-term memory, using the following tests: the Italian version of the Aachen Aphasia Test (AAT; Luzzatti et al., 2023), the auditory grammaticality judgment task, the memory task of the Batteria per l'Analisi dei

Deficit Afasici (BADA; Miceli et al., 1994), and both forward and backward Digit Span (Monaco et al., 2013).

2.3 Experimental materials

Examples of the stimuli used to test the comprehension and production of sentences with relative clauses are provided in (4–8). The protocol included subject (4), object (5), and passive (6) relatives with only singular DPs, as well as subject (7) and object (8) relatives featuring number mismatch between the two DPs in the sentence. Examples of the corresponding images used in the tasks are shown in Figure 1.

To minimize lexical processing demands, the stimuli included only eight nouns for human male-gendered entities: *Bambino* – 'child', *cuoco* – 'cook', *dottore* – 'doctor', *ladro* – 'burglar', *mago* – 'magician', *prete* – 'priest', *soldato* – 'soldier', and *vecchietto* – 'oldie'. For the same reason, we selected only six transitive action verbs: *Applaudire* – 'to applaud', *bagnare* – 'to wet', *colorare* – 'to paint', *colpire* – 'to hit', *inseguire* – 'to chase', and *spingere* – 'to push'. All sentences were reversible and items were pseudorandomised in the protocol.

(4) *Indica il mago$_i$ che* t$_i$ *spinge il cuoco*
'Point to the magician$_i$ that t$_i$ pushes the cook'

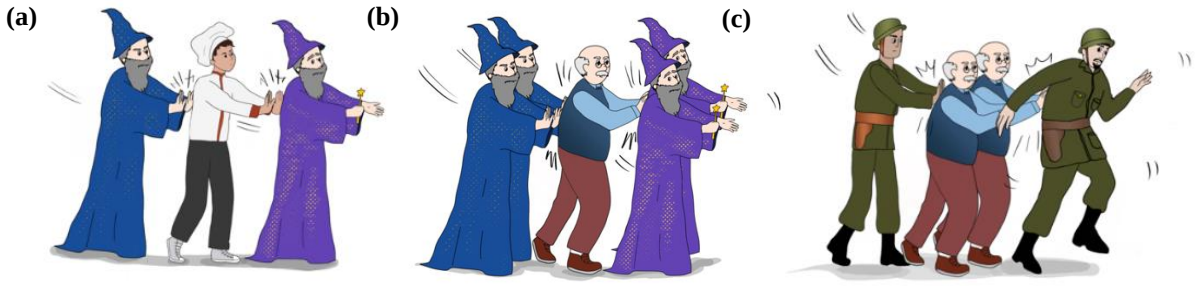
(5) *Indica il mago$_i$ che il cuoco spinge* t$_i$
'Point to the magician$_i$ that the cook pushes t$_i$'

(6) *Indica il mago$_i$ che* t$_i$ *viene spinto* t$_i$ *dal cuoco*
'Point to the magician$_i$ that t$_i$ is pushed t$_i$ by the cook'

(7) *Indica i maghi$_i$ che* t$_i$ *spingono il vecchietto*
'Point to the magicians$_i$ that t$_i$ push the oldie'

(8) *Indica il soldato$_i$ che i vecchietti spingono* t$_i$
'Point to the soldier$_i$ that the oldies push t$_i$'

Figure 1. Example of pictures for (a) subject, object and passive relatives with singular DPs, (b) subject relatives with number mismatch, and (c) object relatives with number mismatch.



2.4 Experimental procedures

Comprehension of relatives was tested using a sentence-to-picture matching task based on character selection. The protocol included 80 sentences with relative clauses: 24 subject relatives, 24 object relatives, and 12 passive relatives. Specifically, 12 subject, 12 object, and 12 passive relatives featured only singular DPs (examples 4-6), while the remaining 12 subject and 12 object relatives involved number mismatch (examples 7-8). Participants listened to each sentence and selected the correct referent in a picture showing three characters or groups of characters (see Figure 1).

Production was tested using a sentence priming task with the same type of stimuli used in the comprehension task. The protocol included 12 subject, 12 object, and 6 passive relatives. To facilitate priming, different types of relatives were tested in separate blocks. Participants were presented with a picture and a corresponding model sentence; then, they were asked to describe a series of pictures by using the same syntactic structure.

The protocol yielded ceiling performance in the control group, supporting its validity.

2.5 Statistical analyses

Given the limited number of participants, we conducted comparisons across experimental conditions using the nonparametric Wilcoxon signed-rank test. However, since no comparisons reached statistical significance, we provide instead individual results and group-level tendencies using descriptive statistics. To estimate the magnitude of contrasts relevant to the study, we report both differences in percentage accuracy (Δ) and Cohen's h coefficient (Cohen, 1988).

3. RESULTS

3.1 Standardised aphasia assessment

Table 2 reports individual results from the standardised assessment. Performance on the linguistic tests showed interindividual variability. Overall, all participants reported poor performance in short-term and working memory tasks.

Table 2. Performance of the participants at standardised assessment.

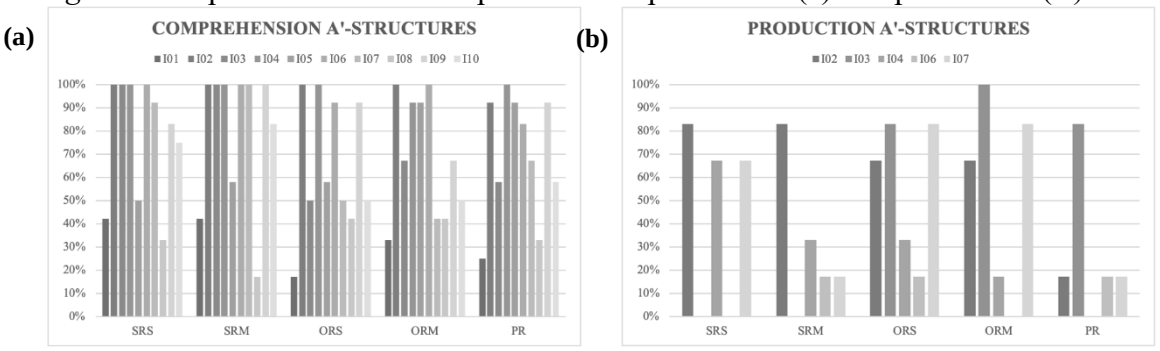
ID	I01	I02	I03	I04	I05	I06	I07	I08	I09	I10
AAT										
Communication	2	2	2	2	1	3	2	1	2	2
Articulation	3	2	2	2	1	3	3	2	2	1
Automated lang.	3	3	4	3	1	4	4	4	3	4
Semantic struct.	3	4	3	3	0	4	4	1	3	4
Phonemic struct.	4	4	2	2	0	3	4	1	4	3
Syntactic struct.	2	1	1	1	0	2	1	1	1	0
Token test	56	57	43	62	56	55	55	43	48	49
Repetition	46	49	56	45	39	52	56	47	50	53
Written lang.	42	48	55	47	41	40	60	51	57	60
Naming	45	52	62	54	40	50	61	47	52	54
Comprehension	51	55	63	52	66	38	58	41	55	58
H. Profile	46.56	50.94	55.64	50.25	43.88	48.15	58.08	46.95	52.18	54.72
BADA										
Gram Jud	20	6	7	5	1	8	2	3	13	0
Memory	0	0	5	0	0	3	3	0	3	1
DIGIT SPAN										
Forward	3	3	3	3	3	4	3	3	3	3
Backward	2	2	3	3	2	2	2	2	2	2

Notes. H. Profile=averaged level of performance. Gram Jud=BADA grammaticality judgements. na=not administrable.

3.2 Comprehension of relatives

Results of the comprehension task for subject, object, and passive relatives are presented in Table 3 and Figure 2a. Performance is characterised by high interindividual variability. Overall, three out of ten participants (I02, I04, I06) performed almost at ceiling with all types of relatives, while five (I01, I03, I07, I09, I10) performed better on subject than on object relatives. Number mismatch in object relatives was associated with improved performance in two participants (I03 and I05), and with decreased performance in one participant (I09).

Figure 2. Proportion of correct response in comprehension (a) and production (B) tasks.



Notes. SRS=subject relatives with singular arguments; SRM=subject relatives with number mismatch; ORS=object relatives with singular arguments; ORM=object relatives with number mismatch; PR=passive relatives.

Table 3. Individual performance in the comprehension task for relatives.

ID	I01	I02	I03	I04	I05	I06	I07	I08	I09	I10	Mean(SD)
SRS	42%	100%	100%	100%	50%	100%	92%	33%	83%	75%	78%(26)
SRM	42%	100%	100%	100%	58%	100%	100%	17%	100%	83%	80%(30)
ORS	17%	100%	50%	100%	58%	92%	50%	42%	92%	50%	65%(29)
ORM	33%	100%	67%	92%	92%	100%	42%	42%	67%	50%	68%(26)
PR	25%	92%	58%	100%	92%	83%	67%	33%	92%	58%	70%(26)
TOT SR	42%	100%	100%	100%	54%	100%	96%	25%	92%	79%	79%(28)
TOT OR	25%	100%	58%	96%	75%	96%	46%	42%	79%	50%	67%(26)
Δ SR M-S	0%	0%	0%	0%	8%	0%	8%	-17%	17%	8%	3%
***h* SR M-S**	0	0	0	0	0.167	0	0.586	-0.390	0.841	0.206	0.061
Δ OR M-S	17%	0%	17%	-8%	33%	8%	-8%	0%	-25%	0%	3%
***h* OR M-S**	0.390	0	0.340	-0.586	0.818	0.586	-0.167	0	-0.645	0	0.071
Δ SR-OR	17%	0%	42%	4%	-21%	4%	50%	-17%	13%	29%	12%
***h* SR-OR**	0.356	0	1.403	0.411	-0.440	0.411	1.243	-0.356	0.362	0.623	0.273
Δ PR-OR	0%	-8%	0%	4%	17%	-13%	21%	-8%	13%	8%	3%
***h* PR-OR**	0	-0.586	0	0.411	0.462	-0.430	0.423	-0.172	0.362	0.167	0.072

Notes. SRS=subject relatives with singular DPs; SRM=subject relatives with number mismatch; ORS=object relatives with singular DPs; ORM=object relatives with number mismatch; PR=passive relatives; M=number mismatch; S=all singular DPs; Δ=difference in accuracy (%); *h*=Cohen's *h*.

3.3 Production of relatives

Results of the production task for subject, object, and passive relatives are presented in Table 4 and Figure 2b. Five out of ten participants did not complete the task due to severe extra-syntactic deficits. Of the remaining five participants, two (I02 and I04) performed better on subject relatives than on object relatives, while two others (I03 and I07) showed the opposite pattern. Additionally, one participant (I03) reported better performance in the presence of number mismatch, while two participants (I04 and I07) showed the inverse pattern.

Table 4. Individual performance in the production task for relatives.

ID	I01	I02	I03	I04	I05	I06	I07	I08	I09	I10	Mean(SD)
SRS	na	83%	0%	67%	na	0%	67%	na	na	na	43%(40)
SRM	na	83%	0%	33%	na	17%	17%	na	na	na	30%(32)
ORS	na	67%	83%	33%	na	17%	83%	na	na	na	57%(30)
ORM	na	67%	100%	17%	na	0%	83%	na	na	na	53%(43)
PR	na	17%	83%	0%	na	17%	17%	na	na	na	27%(32)
TOT SR	na	83%	0%	50%	na	8%	42%	na	na	na	37%(34)
TOT OR	na	67%	92%	25%	na	8%	83%	na	na	na	55%(37)
Δ SR M-S	na	0%	0%	-33%	na	17%	-50%	na	na	na	-13%
***h* SR M-S**	na	0	0	-0.680	na	0.841	-1.070	na	na	na	-0.278
Δ OR M-S	na	0%	17%	-17%	na	-17%	0%	na	na	na	-3%
***h* OR M-S**	na	0		-0.390	na	-0.841	0	na	na	na	-0.067
Δ SR-OR	na	17%	-92%	25%	na	0%	-42%	na	na	na	-18%
***h* SR-OR**	na	0.390	-2.556	0.524	na	0	-0.897	na	na	na	-0.370
Δ PR-OR	na	-50%	-8%	-25%	na	8%	-67%	na	na	na	-28%
***h* PR-OR**	na	-1.070	-0.255	-1.047	na	0.255	-1.459	na	na	na	-0.586

Notes. SRS=subject relatives with singular DPs; SRM=subject relatives with number mismatch; ORS=object relatives with singular DPs; ORM=object relatives with number mismatch; PR=passive relatives; M=number mismatch; S=all singular DPs; Δ=difference in accuracy (%); *h*=Cohen's *h*.

4. DISCUSSION

The results of the study revealed substantial variability among participants in both comprehension and production tasks. This variability is consistent with the heterogeneity of the sample in terms of aphasia severity, although all participants presented a profile compatible with nonfluent agrammatic aphasia. As anticipated in the introduction, performance variability may also reflect inter-individual fluctuations due to clinical factors, attentional variability, or task-induced cognitive load. Furthermore, as will be discussed in detail below, differences in short-term memory resources and in the preservation versus impairment of morphological processing may, at least partially, account for the observed variations in performance.

Consequently, neither the predictions of the Trace Deletion Hypothesis (Grodzinsky, 2000) nor those of the Generalized Minimality account (Grillo, 2008) appear to be fully confirmed by overall group trends, at least at first glance. In the following sections, we will examine the results in greater detail to identify relevant patterns within this variability.

4.1 Subject advantage in comprehension

In the comprehension task, the prediction of better performance with subject relatives is overall confirmed. asExcluding the three participants with ceiling accuracy across all structures, five out of seven participants showed a subject advantage. This result is compatible with both the Trace Deletion Hypothesis and with Generalized Minimality. However, the variability in the data suggests that the latter approach, combining structural and resource-based components, is more convincing.

Indeed, cases of good performance with both subject and object relative in agrammatism have been previously reported in the literature (e.g., Nerantzini et al., 2014 for Greek).

As for the two participants who presented the unexpected response pattern, with higher accuracy for object relatives, an individualised explanation can be attempted. For I08, the difference is very small, and the accuracy is below chance for both structures. Conversely, I05 performed at chance on all structures except for object relatives with number mismatch (92%). Given her severely impaired repetition (AAT) and short-term memory skills (BADA and Digit Span), it is plausible that I05 relied on a partial-processing strategy, using subject-verb agreement cues at the end of the sentence to infer the correct referent.[22] While this superficial heuristic could, in principle, be employed by other, less impaired, patients, the performance patterns suggest it was uniquely adopted by I05.

4.2 Number mismatch in comprehension

As noted above, three of the ten participants performed with very high accuracy across all structures, making it impossible to assess any mismatch-related facilitation. Among the remaining seven, only two participants showed a potential facilitation effect. I03 performed at chance level with object relatives without number mismatch but above chance when mismatch was present (67%), while performing at ceiling on subject relatives. I05 also showed improved performance with mismatched object relatives; however, as discussed earlier, this behaviour may rely on superficial strategies rather than full syntactic comprehension. Conversely, I09 exhibited the opposite pattern: higher accuracy with object relatives without mismatch (92%) than with mismatch (67%). Given I09's poor performance on BADA's grammaticality judgment task, this pattern may reflect a morphological deficit that impairs processing of number features, rendering number mismatch disruptive rather than helpful. The remaining four participants showed no substantial effects of number mismatch. For two of them, below-chance accuracy across all structures suggests that aphasia severity may have precluded any facilitation. For the other two, no clear reason emerges, and we can speculate that the morphological deficit has nullified any potential benefit of number mismatch.

Interestingly, despite variability, the results rule out superficial morphological cues as the source of number mismatch effects, since no participant showed general facilitation across subject and object relatives, challenging non-structural similarity accounts (see Terzi & Nanousi, 2018 for Greek).

[22] Note that, based on examples (4-8), this strategy yields the correct response only in the case of object relatives with number mismatch, as in (8).

4.3 Production of relatives

Five out of ten participants were not able to undertake the task, two presented the expected pattern of subject advantage, two reported the inverted pattern, and one showed no difference. Large discrepancies between comprehension and production abilities are not entirely surprising. In particular, for participants for whom the production task was not feasible, lexical access and/or articulatory difficulties, commonly associated with agrammatism, made it impossible to produce sentences of the type included in the protocol. This often led to task abandonment or refusal to attempt the production trials.

The marked interindividual variability and the overall lower performance in production in comparison with comprehension may support an explanation in terms of modality-specific syntactic processing with impaired representation of the higher projection of the syntactic tree in production in agrammatism (Tree Pruning Hypothesis; Friedmann, 2001). However, I02 and I04 showed the expected subject advantage in production, alongside ceiling-level comprehension performance. This pattern suggests that the two modalities may rely on a shared underlying syntactic representation, with comprehension supporting production.[23] Furthermore, I02's high production accuracy in subject relatives challenges the idea of truncation of the syntactic tree.

Moving to the inverse pattern of performance, this may be explained by the order of testing, as subject relatives were always presented first. I03 and I07 may have initially struggled to engage with the sentence priming task, independently of structural complexity. Indeed, priming might operate on superficial similarities rather than on full syntactic processing (Branigan, 2007). Furthermore, lexical, phonological or articulation impairments may have contributed to the overall poor production, masking potential syntactic effects.

In accordance with both the inconsistent response patterns in production and the methodological limitations noted above, no effect of number mismatch emerged. This fact may also reflect selective morphological deficits in a subgroup of individuals with agrammatism (Beber et al., 2024), which could block any mismatch-related facilitation.

[23] This pattern is consistent with findings from a rehabilitation study on agrammatism in German, which also reported that preserved comprehension supported production outcomes (Schröder et al., 2015).

4.4 The performance with passive relatives

In typical language development, passive relatives were found easier than object relatives by Belletti and Contemori (2010), who propose that children may avoid minimality effects in relatives via smuggling (Collins, 2005). However, for our participants, passive relatives proved particularly challenging, especially in production, suggesting that language acquisition and agrammatism are different in this respect and that agrammatism is characterized by a specific deficit with passives (see also Gilardone et al., 2023), possibly due to a disrupted representation of the smuggling operation.

4.5 Limitations and future developments

This study is limited by the small sample size; therefore, our findings need to be confirmed through group analyses involving a larger number of participants and experimental items. It is also limited by the relatively limited characterization of participants from neurological (absence of neuroimaging data), neuropsychological, and linguistic perspectives: all of which could help account for the observed variability. In particular, a standardized assessment of morphological processing, which is currently unavailable in Italian, could further clarify the patterns of performance. Indeed, the facilitation induced by grammatical number mismatch presupposes correct encoding and decoding of morphophonological information both upstream (in comprehension) and downstream (in production) of morphosyntactic processing. Furthermore, future research could also extend cross-linguistically the analysis of these phenomena and investigate competing hypotheses on passives through targeted manipulations of morphosyntactic features.

5. CONCLUSION

This study explored the subject-object asymmetry in the comprehension of relatives among Italian speakers with agrammatism, confirming an overall subject-relative advantage despite marked interindividual variability. Number mismatch occasionally facilitated object-relative comprehension; the effect was inconsistent, yet incompatible with facilitation based on superficial morphological cueing. In production, no reliable pattern emerged, likely due to extra-syntactic deficits and task-related limitations. The findings also point to specific difficulties with passivisation in agrammatism. Overall, linguistic theory proved essential in interpreting these complex data, with Generalized Minimality offering the better, yet not unchallenged, account.

REFERENCES

Adani, F., Van der Lely, H. K., Forgiarini, M., & Guasti, M. T. (2010). Grammatical feature dissimilarities make relative clauses easier. *Lingua*, *120*(9), 2148-2166. https://doi.org/10.1016/j.lingua.2010.03.018

Adelt, A., Burchert, F., Adani, F., & Nicole, S. (2020). What matters in processing German object relative clauses in aphasia-timing or morpho-syntactic cues?. *Aphasiology*, *34*(8), 970-998. https://doi.org/10.1080/02687038.2019.1645290

Adelt, A., Stadie, N., Lassotta, R., Adani, F., & Burchert, F. (2017). Feature dissimilarities in the processing of German relative clauses in aphasia. *Journal of Neurolinguistics*, *44*, 17-37. https://doi.org/10.1016/j.jneuroling.2017.01.002

Beber, S., Bontempi, G., Miceli, G., & Tettamanti, M. (2024). The Neurofunctional Correlates of Morphosyntactic and Thematic Impairments in Aphasia. *Neuropsychology Review*, 1-34. https://doi.org/10.1007/s11065-024-09648-0

Belletti, A., & Contemori, C. (2010). Intervention and attraction: On the production of Subject and Object Relatives by Italian (young) children and adults. In *Language Acquisition and Development, Proceedings of Gala 2009*. Cambridge Scholars Press.

Belletti, A., Friedmann, N., Brunato, D., & Rizzi, L. (2012). Does gender make a difference? Comparing the effect of gender on children's comprehension of relative clauses in Hebrew and Italian. *Lingua*, *122*(10), 1053-1069. https://doi.org/10.1016/j.lingua.2012.02.007

Branigan, H. (2007). Syntactic priming. *Language and Linguistics Compass*, *1*(1-2), 1-16. https://doi.org/10.1111/j.1749-818X.2006.00001.x

Caplan, D., Waters, G., DeDe, G., Michaud, J., & Reddy, A. (2007). A study of syntactic processing in aphasia. *Brain and Language*, 101(2), 103-150. https://doi.org/10.1016/j.bandl.2006.06.225

Caramazza, A., & Zurif, E. B. (1976). Dissociation of algorithmic and heuristic processes in language comprehension. *Brain and Language*, 3(4), 572-582. https://doi.org/10.1016/0093-934X(76)90048-1

Collins, C. (2005). A smuggling approach to the passive in English. *Syntax*, *8*(2), 81-120. https://doi.org/10.1111/j.1467-9612.2005.00076.x

Friedmann, N. (2001). Agrammatism and the psychological reality of the syntactic tree. *Journal of Psycholinguistic Research*, 30, 71-90. https://doi.org/10.1023/A:1005256224207

Friedmann, N. (2008). Traceless relatives: Agrammatic comprehension of relative clauses with resumptive pronouns. *Journal of Neurolinguistics*, *21*(2), 138-149. https://doi.org/10.1016/j.jneuroling.2006.10.005

Friedmann, N., Reznick, J., Dolinski-Nuger, D., & Soboleva, K. (2010). Comprehension and production of movement-derived sentences by Russian speakers with agrammatic aphasia. *Journal of Neurolinguistics*, *23*(1), 44-65. https://doi.org/10.1016/j.jneuroling.2009.08.002

Gilardone, G., Viganò, M., Costantini, G., Monti, A., Corbo, M., Cecchetto, C., & Papagno, C. (2023). The role of verbal short-term memory in complex sentence comprehension. *International Journal of Language & Communication Disorders*. https://doi.org/10.1111/1460-6984.12851

Grillo, N. (2008). *Generalized Minimality*. Utrecht Institute of Linguistics, OTS.

Grodzinsky, Y. (2000). The neurology of syntax: Language use without Broca's area. *Behavioral and Brain Sciences*, *23*(1), 1-21. https://doi.org/10.1017/s0140525x00002399

Koopman, H., & Sportiche, D. (1991). The position of subjects. *Lingua*, 85(2-3), 211-258. https://doi.org/10.1016/0024-3841(91)90022-W

Lukatela, K., Shankweiler, D., & Crain, S. (1995). Syntactic processing in agrammatic aphasia by speakers of a Slavic language. *Brain and Language*, *49*(1), 50-76. https://doi.org/10.1006/brln.1995.1021

Luzzatti, C., De Bleser, R., Scola, I., Frustaci, M., & Willmes, K. (2023). Update on the psychometric properties for the Italian version of the Aachen Aphasia Test (IT-AAT). *Aphasiology*, 37(4), 658-695. https://doi.org/10.1080/02687038.2022.2037501

Miceli, G., Laudanna, A., Burani, C. & Capasso, R. (1994). *BADA. Batteria per l'Analisi dei Deficit Afasici*. Università Cattolica del Sacro Cuore.

Monaco, M., Costa, A., Caltagirone, C., & Carlesimo, G. A. (2013). Forward and backward span for verbal and visuo-spatial data. *Neurological Sciences*, 34(5), 749-754. https://doi.org/10.1007/s10072-012-1130-x

Nerantzini, M., Varlokosta, S., Papadopoulou, D., & Bastiaanse, R. (2014). Wh-questions and relative clauses in Greek agrammatism. *Aphasiology*, *28*(4), 490-514. https://doi.org/10.1080/02687038.2013.870966

Rizzi, L. (2018). Intervention effects in grammar and language acquisition. *Probus*, *30*(2), 339-367. https://doi.org/10.1515/probus-2018-0006

Schröder, A., Burchert, F., & Stadie, N. (2015). Training-induced improvement of noncanonical sentence production does not generalize to comprehension. *Cognitive Neuropsychology*, 32(3-4), 195-220. https://doi.org/10.1080/02643294.2014.968535

Terzi, A., & Nanousi, V. (2018). Intervention effects in the relative clauses of agrammatics. *Glossa*, *3*(1). https://doi.org/10.5334/gjgl.274

Varlokosta, S., Nerantzini, M., Papadopoulou, D., Bastiaanse, R., & Beretta, A. (2014). Minimality effects in agrammatic comprehension. *Lingua*, 148, 80-94. https://doi.org/10.1016/j.lingua.2014.05.013