

## QUESTION PRODUCTION IN ITALIAN-SPEAKING PWAGR

**Abstract:** This paper presents the results of an elicitation task run with Italian-speaking people with agrammatic aphasia (PWAGR). Linguistic theories of aphasia have analysed the production of PWAGR as stemming either from a deterioration of grammatical knowledge or a limitation of extra-linguistic capacities which affect language. Among the former, the Tree Pruning Hypothesis (Friedmann and Grodzinsky, 1997) relates the height of the projections involved in the production of a structure with the chances of it being produced: the stronger the impairment in the speaker, the less likely they are to produce a structure involving higher nodes. Alternatively, syntactic knowledge may be preserved but its use is compromised by Working Memory (WM) limitations (e.g., Miyake et al., 1994; Jakubowicz, 2005). The two approaches make different predictions with respect to question production in Italian: according to the TPH, the production rates of yes/no-questions and *who*-questions should be comparable in moderate and mild aphasia. *Why*-questions involve a higher node and should thus not be available. Under a WM-limitation approach, the production rates of *why*-questions and yes/no-questions should be comparable and higher than those of *who*-questions. To determine which, if any, of the two approaches makes the correct predictions, three adult Italian speakers diagnosed with Broca's aphasia and one with anomia performed an elicitation task targeting these three types of structures. Overall, yes/no-questions were the most frequent structures to be produced. The lack of *who*-questions, as opposed to the production of yes/no-questions, can be accounted for only if derivational complexity is taken into account, but the scarcity of *why*-questions suggests that the height of the nodes involved may play a role as well.

**Key words:** aphasia, production, syntax, working memory, questions

### 1. Introduction

One way in which linguistically informed accounts of aphasia can be distinguished concerns the assumed source of impairments. Two main views can be identified: either grammatical knowledge is deteriorated, or it is preserved but its access is limited by reduced processing resources. Caramazza and Zurif (1976) proposed one of the first 'structural' accounts of agrammatic aphasia: under this view, language deficits in people with agrammatic aphasia (PWAGR) are due to a breakdown of syntactic knowledge. Several influential theories have built on this intuition.

The Trace Deletion Hypothesis (Grodzinsky, 1986) identifies in moved elements the source of poor comprehension observed with sentences which do not respect canonical word order. Structural accounts such as the ones discussed in Hagiwara (1995) and Novaes and Braga (2005) propose specific nodes of the syntactic tree to be unavailable to PWAGR. Similarly, the Tree Pruning Hypothesis (Friedmann & Grodzinsky, 1997) draws a direct correlation between the severity of aphasia and the number of nodes available: the more severe the pathology, the lower the point of *pruning* of the syntactic tree.

Grillo (2008) and Garaffa and Grillo (2008) apply the notion of Relativized Minimality (Rizzi, 1990) to account for the poor comprehension of non-canonical sentences such as Object Relatives (OR) and *wh*-object questions.

One of the drawbacks of such structural accounts is that they assume a unitary conceptualization of aphasia, which has been questioned by several authors. Badecker and Caramazza (1985), for example, argue that 'agrammatic' aphasia is an arbitrary category and that no structural account of the pathology can account for the variability observed among PWAGR. Crucially, this variability is observed both intra-individuals and intra-tasks: different methodologies can, in fact, yield differences in performance (Linebarger et al., 1983; Caplan et al., 2007). This poses a substantial issue to structural accounts of aphasia, as they are based on methodologically limited experimental data. Certain structures might be difficult in a

picture-matching task, but not in a grammaticality judgment, as work by Linebarger et al. (1983) first showed. If a certain structure remains preserved in at least one type of task, it cannot be argued that this structure is no longer available in the grammar.

Assuming no breakdown of syntactic knowledge, the second view thus focuses on the role of extra-syntactic factors which might affect the access and use of language. A number of processing accounts fall under this view (Miceli et al., 1983; Badecker & Caramazza, 1985; Shankweiler et al., 1989; Miyake et al., 1994; Crain et al., 2001; Friedmann & Gvion, 2003; Caplan et al., 2007; Fyndanis et al., 2012, 2018). Among these two main views, accounts vary with respect to, for example, which part of grammatical knowledge is assumed to be lost or which extra-linguistic resources interact with language-specific complexity factors.

The present work explores and compares predictions based on a strong syntactic account such as the Tree Pruning Hypothesis (Friedmann and Grodzinsky, 1997) with predictions based on Working Memory limitation accounts (such as, e.g., Miyake et al., 1994; Jakubowicz, 2005). The aim of the study is to identify which, if any, of the two competing approaches best predicts the empirical findings. The hypotheses are tested against the production of three types of questions in Italian-speaking PWAgr. Following previous literature, yes/no-questions and *who*-subject questions were chosen as a testing ground; *why*-questions were added as they represent the strongest point of disagreement between the structural and WM-limitation account. Thus, the research questions are:

1. Do native speakers of Italian with aphasia show an impairment in the production of: yes/no-questions, *who*-questions and *why*-questions?
2. If they do, is there a difference among the three types of questions?
3. If there is a difference, can the impairment be better explained by TPH or a WM-limitation account?

Under the TPH, all questions are expected to be impaired. Under a WM-limitation account, the production of *who*-subject questions is expected to be more impaired than the production of yes/no-questions and *why*-questions.

	Yes/No	Why	Who
<b>TPH</b>	×	×	×
<b>WM</b>	✓	✓	×

Table 1. Predictions: impaired (×) and preserved (✓) structures.

Given the available data on Italian (Chinellato, 2003; Garraffa, 2003) and results from previous studies on question production with agrammatic PWAgr (e.g., Friedmann, 2002; Burchert et al., 2005; Martínez Ferreiro, 2007), it is expected for Italian-speaking PWAgr to show an unimpaired production of yes/no-questions and *why*-questions, counterposed with an impaired production of *who*-subject questions.

In the next section, an overview of the two accounts at hand is presented. In section 3, the aims of the current study are presented, along with the research questions and methodology of the Italian question-production experiment. In section 4 and 5 the results are presented and discussed.

## 2. Theoretical background

Empirical research on agrammatic aphasia reveals that not all syntactic knowledge is lost at the onset of the pathology (see, e.g., reviews by Druks, 2016; Garraffa & Fyndanis, 2020). Friedmann and Grodzinsky (1997) have proposed an explanation of the different impairment degrees in production based on a strongly syntactic approach, whereby the stronger the impairment, the more syntactic knowledge is assumed to be lost.

On the other end of the spectrum, WM-limitation accounts such as the one assumed in Miyake et al. (1994) or Fyndanis et al. (2012, 2018) assume that language impairments in aphasia may derive from an inability to maintain, manipulate and process linguistic material as a result of WM limitations.

### 2.1. The Tree Pruning Hypothesis

The Tree Pruning Hypothesis (TPH) stems from a strongly structural approach to the study of agrammatic aphasia, which has its roots in both the study of language pathologies (e.g., Hagiwara, 1995) and child language acquisition (e.g., Rizzi, 1993/4). When production and/or comprehension deviate from what is expected, either because the rules of language have not been yet acquired or because of a pathology affecting the language system, it may be the case that the deep syntactic knowledge is in some way defective.

Rizzi (1993/4) observed that children aged 2 who are native speakers of languages such as English and French produce verbs in their infinitival form in contexts in which adult grammars would not allow them. Rizzi introduced Truncation as a mechanism employed by young children who, by ‘truncating’ the tree at a node lower than TP, produce verbs with no tense specifications. Under the Truncation Hypothesis, it is assumed that the structure is developed: children do not produce tenseless verbs because they lack the TP, rather this optional mechanism sometimes causes non-target-like production. Children who produce root infinitives, in fact, may produce fully inflected verbs in other contexts, such as *wh*-questions.

On a similar note, Hagiwara (1995) assumed that the syntactic structure is preserved in PWAgr, but higher nodes may at times not be accessible. This entails that sentences which involve the use of the lower portion of the tree are expected to be produced and/or comprehended, while sentences involving higher nodes may not be equally available. Hagiwara relates this asymmetry to the operations Merge and Move (Chomsky, 1995): the elements of a sentence are first Merged in the syntactic tree and some are subsequently Moved to a different position of the tree. By and large, it can be assumed that elements are first merged in a low position, and reach the higher nodes through the operation Move. Hagiwara thus proposes that the reason why higher nodes are less available is because their use entails repeated Move operations, an activity which may be too demanding for the language system of PWAgr.

The vulnerability of the higher nodes is likewise assumed by the Tree Pruning Hypothesis proposed in Friedmann and Grodzinsky (1997). However, the cause of this vulnerability differs from what has been proposed in Hagiwara (1995). The TPH is based on an observed asymmetry between Tense and Agreement in the production of a Hebrew speaker diagnosed with Broca’s aphasia. While no asymmetry was observed in comprehension, the participant showed a very poor production of tense morphology, with errors ranging from substitutions to omissions. Agreement, on the other hand, was nearly intact and performance was close to normal. The results from the production task led to the hypothesis that some of the nodes along the syntactic tree might be impaired, depending on their height.

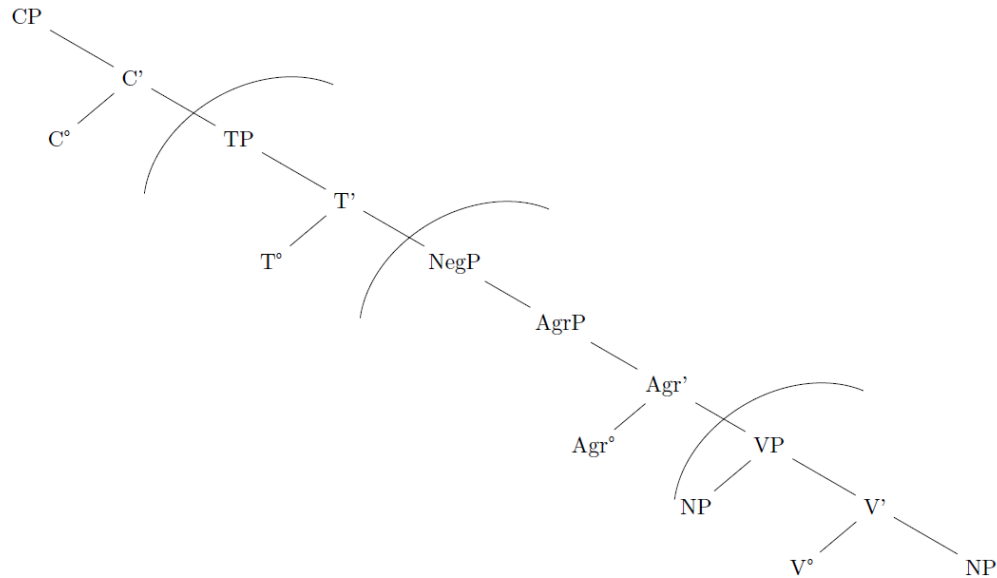


Figure 1. The Tree Pruning Hypothesis

Within this scheme, in the most severe cases of aphasia every node above the VP is assumed to be damaged. In moderate cases of aphasia, the Tense node is assumed to be impaired while Agreement is preserved. In mild cases of aphasia, the Tense node is preserved as well, whereas the CP is always assumed to be pruned. This provides an explanation for the observed asymmetry in the production of the relevant morphology reported in Friedmann and Grodzinsky (1997).

To determine the status of the higher parts of the tree and whether an impaired TP implies the loss of the CP or not, the production of *wh*-questions and embedded clauses was tested with the same Hebrew speaker. In line with previous research on aphasia, the participant showed significant difficulties in the production of *wh*-questions as well as in the use of embedded clauses, avoiding such structures when possible. Thus, if a lower node is impaired, it seems that the higher nodes are lost as well.

The potential advantage of a structural account such as the TPH is that it allows us to make specific predictions about the production of a variety of structures by simply taking into account the height of the relevant nodes and the severity of a speaker's pathology. The current study focuses on the production of questions, for which structure the TPH makes strong predictions.

In a study involving Hebrew, Arabic and English-speaking aphasics, Friedmann (2002) tested the production of *wh*-questions and yes/no-questions. The results of Hebrew and Arabic-speaking participants show a significant difference between the production of yes/no-questions and *wh*-questions, both at a group and an individual level: while the former are relatively well-preserved (148/170 total elicitation stimuli), *wh*-questions were produced in fewer cases (64/285). The results of the English-speaking participant yielded rather different data: no target-like questions were produced, with no difference between yes/no-questions and *wh*-questions. The latter results are in line with previous literature covering question production among English-speaking PWAgr (Goodglass et al., 1972; Myerson & Goodglass, 1972; Bastiaanse & Thompson, 2003) with data repeatedly showing an impaired production of yes/no questions which parallels that of *wh*-questions. The cross-linguistic asymmetry which emerged in the study is explained in Friedmann (2002) by assuming that yes/no-questions in Hebrew and Arabic do not involve the CP, contrary to English (Friedmann, 2002:164):

- (1) 'at ohevet xumus?  
you like hummus  
'Do you like hummus?'

- (2) *ha-yare 'ax haya male etmol?*  
the-moon was full yesterday  
‘Was the moon full yesterday?’

As can be observed in examples (2) and (3), Hebrew yes/no-questions parallel the structure of a simple SVO sentence, and no element appears in a position higher than the subject. Hence, in Hebrew and Arabic *wh*-questions are assumed to involve a higher node, i.e. the CP, while yes/no-questions do not. In English, on the other hand, both *wh*-questions and yes/no-questions are assumed to involve the higher part of the tree. In line with the TPH, it is expected for English-speaking PWAGR to have an equally impaired production of these types of questions, whereas in Hebrew and Arabic it is expected for yes/no-questions to be preserved in mild and moderate cases of aphasia.

The explanation proposed in Friedmann (2002), however, does not take into account the role of the Q(uestion) operator. The necessity for yes/no-questions to involve an operator was first emphasized by Katz and Postal (1964), who argued for a Q operator on semantic grounds: both *wh*- and yes/no-questions must incorporate an operator that expresses the interrogative reading of the structure. Thus, regardless of there being an overt item or not, a Q operator can be assumed in yes/no-questions of all languages, in line with the Uniformity Principle (e.g., Chomsky, 2001).

Adopting Rizzi’s (1997) cartographic approach, the Q operator is located in Q/FocP, i.e. in the lower left periphery. This entails that the highest portion of the tree is cross-linguistically always involved in the derivation of questions. As a consequence, the TPH seems not to be sufficient to explain the asymmetry pointed out in Friedmann (2002).

## 2.2. WM-limitation accounts

The relation between Working Memory (WM) and language and the way that WM limitations affect language has been widely addressed in the literature (e.g., Just & Carpenter, 1992; King & Just, 1991; Hartsuiker & Barkhuysen, 2006, among others). In some pathological populations, including people with agrammatic Broca’s aphasia, the language pathology is accompanied by WM deficits (Caplan & Waters, 1999; Sung et al., 2009; Laures-Gore et al., 2011; Murray, 2012; Caplan et al., 2013).

The research on the topic suggests that WM limitations could be the main source of impairment in agrammatic aphasia. An account relating WM limitations to patterns of comprehension breakdown in aphasia has been proposed in Miyake et al. (1994). What has been crucially observed by Miyake et al. in the comprehension of PWAGR is that while the severity of comprehension deficits may vary among aphasic speakers, the patterns of comprehension do not: the structures which are most difficult for severely impaired PWAGR are the most difficult for mild and moderate cases of aphasia as well. These common patterns have been put in relation to both variation in WM capacity and variation in the degree of syntactic complexity of the linguistic material.

Data from language processing among healthy subjects (e.g., King & Just, 1991) indeed suggests that additional tasks which are demanding on WM negatively affect language comprehension. However, this is true only when sentences are somewhat complex. The same has been observed in children, especially children with developmental language pathologies. Work with monolingual and bilingual children (Jakubowicz & Strik, 2008; Prévost et al., 2014) and children with SLI (Jakubowicz, 2011), for example, has explored and tested the Derivational Complexity Hypothesis (DCH) put forward in Jakubowicz (2005). At the core of the DCH is the idea that working memory is among the developmental constraints that affect language development and as such is sensitive to the computational complexity of constructions. This, according to Jakubowicz, leads children to prefer simpler constructions, which are less demanding on their limited resources. The complexity of each structure is rigorously defined through the Derivational Complexity Metric, which takes into account the number of (Internal) Merge operations (Chomsky, 2001) an element undergoes and the number of elements involved in the re-iterated Merge operation:

- (3) Derivational Complexity Metric (Jakubowicz, 2005):

- a. Merging  $\alpha_i$   $n$  times gives rise to a less complex derivation than merging  $\alpha_i$   $(n + 1)$  times.
- b. Internal Merge of  $\alpha$  gives rise to a less complex derivation than Internal Merge of  $\alpha + \beta$ .

The Derivational Complexity Hypothesis offers a simple and clear system for determining and comparing the complexity of syntactic structures.

While the DCH has been so far employed in research concerning language acquisition, it is clear that its potential applications go far beyond the study of a developing system. As discussed in section 2.1, structural accounts in the fields of language acquisition and clinical linguistics have heavily borrowed from and influenced each other. The DCH provides the theoretical means to define what makes a structure complex, a necessary step in order to approach the study of language pathologies through the lens of a processing account.

Under WM-limitations accounts, such as the one proposed in Miyake et al. (1994), the successful use of a structure can be predicted on the basis of its complexity degree. Without a clear definition of syntactic complexity, however, it remains unclear how to predict the likelihood of a structure being comprehended and/or produced.

In the current study, I adopt the Derivational Complexity Metric proposed by Jakubowicz (2005) to define the complexity degree of a structure and make predictions which follow from a WM-limitation account. A hierarchy of complexity can be established, for example, for yes/no-questions and *wh*-questions across languages. In the following section, I will discuss how the complexity degree varies among different types of questions and across different languages, with a particular focus on Italian questions.

### 3. Questions in Italian

Interrogative structures have been used as a testing ground in a large number of studies across different languages and populations, including children with typical and atypical language acquisition (Clahsen et al., 1995; DeVicenzi et al., 1999; Avrutin, 2000; Hamann, 2006; Friedmann & Novogrodsky, 2011; Jakubowicz, 2011; Guasti et al., 2012;), as well as adults with normal and pathological comprehension and production (de Vicenzi, 1991; Hickoc & Avrutin 1996; Thompson et al., 1999; Avrutin, 2000; Friedmann, 2002; Neuhaus & Penke, 2008; Burchert et al., 2005; Goodluck, 2005; Dickey et al., 2007; Grillo, 2008; Sheppard et al., 2015). Some common patterns have been observed across population types and across languages: some types of *wh*-questions, for example, seem to be more difficult than others to comprehend and/or produce in both young children and adults with a language pathology; the same structures seem to require more effort to be processed in healthy adults (Contemori et al., 2018). This will be addressed in section 3.2 below. No uniform pattern has emerged from the study of yes/no-questions: within research on aphasia, conflicting results have been reported across different languages. The issue will be addressed in section 3.1.

To identify the type of account which best explains the available data, two aspects need to be taken in consideration. Under a structural account such as the TPH (Friedmann & Grodzinsky, 1997), the nodes of the tree which each type of question involves determines their likelihood of being comprehended and/or produced. Under a WM-limitation account (Miyake et al., 1994; Jakubowicz, 2005), the amount of Internal Merge operations that each structure requires determines their complexity; the more complex a structure is, the less likely it is to be comprehended and/or produced.

Italian questions differ in their derivations as well as in the height of the nodes involved in the derivations. In the following sections I will look at the three types of structures under study in the current work: yes/no-questions, *why*-questions and *who*-questions in Italian. I will define each structure in terms of its complexity degree and height of the nodes involved, in order to define the predictions which the two accounts make about question production in Italian.

### 3.1. Yes/No-questions

Yes/no-questions in Italian allow for two word orders: the subject can either precede the verb (SV) or follow it (VS). The two orders, however, cannot be used interchangeably, as the post-verbal subject in yes/no-questions expresses specific discourse-related properties. A neutral reading is associated with the standard word order of Italian, SVO. In this case, it is only the speakers' intonation which suggests the interrogative nature of the sentence:

- (4) a. *(Io) sono felice.*  
       I am happy  
       b. *(Io) sono felice?*  
       I am happy?  
       ‘Am I happy?’

Yes/no-questions in Italian differ in this respect from *wh*-questions such as *what/where/when*, as these do not allow pre-verbal subjects:

- (5) a. \**Quando Maria è felice?*  
       when Maria is happy  
       b. *Quando è felice Maria?*  
       when is happy Maria  
       ‘When is Maria happy?’

Post-verbal subjects in Italian, observed in *wh*-questions such as (6b), are allowed in declarative sentences as well (7b). Contrary to *wh*-questions, however, the post-verbal subject of declarative sentences bears a non-neutral meaning. In declarative sentences, in fact, the post-verbal subject expresses narrow focus (Selkirk, 1984; Lambrecht, 1942). This refers to the focus of single words or constituents, such as (7b) below (Belletti, 2009), an appropriate answer to a *wh*-question:

- (6) a. *Chi ha telefonato?*  
       who has phoned  
       b. *Ha telefonato Gianni.*  
       has phoned Gianni  
       c. *#Gianni ha telefonato*  
       ‘Gianni has phoned’

In a parallel with the rich structure of the left periphery (Rizzi, 1997), Belletti (2001, 2004, 2009) proposed for the low IP area to be endowed with discourse-related properties such as Topic and Focus. A division of labour is observed between the two areas (CP and IP): new information focus cannot be expressed through the high Focus projection, and it is instead hosted in the low IP position. For this reason, the subject in a declarative sentence can occupy a post-verbal position (as in 7b).

Bocci and Pozzan (2014) observe that questions which allow for pre-verbal subjects, such as yes/no-questions, reflect the same asymmetry observed in declarative sentences. That is, post-verbal subjects are allowed in yes/no-questions when these bear new information, but not in other cases. Post-verbal subjects in *wh*-questions, on the other hand, do not express any specific discourse-related property.

Thus, neutral yes/no-questions are derived as in Figure 2 below:

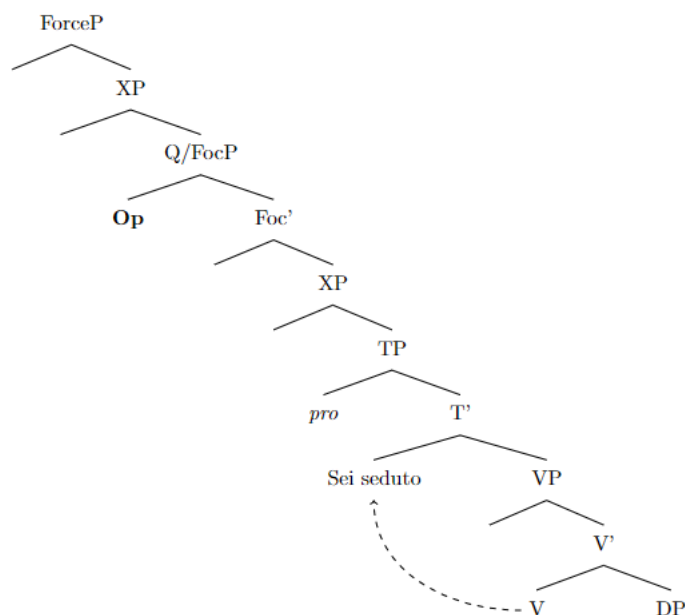
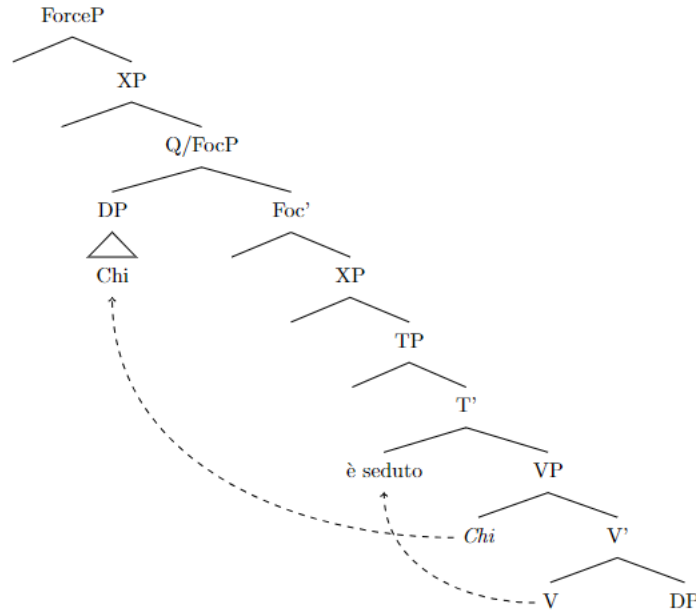


Figure 2. Yes/No-question derivation in Italian

As can be observed in Figure 2, the derivation of a yes/no-question in Italian (*Are you sitting?*) involves a Question Operator (Op) Externally Merged in the specifier of Q/FocP. The null *pro* is similarly Externally Merged in the subject position. As in declarative sentences, the verb moves to T to acquire Tense specifications (Pollock, 1989), but the lack of subject-verb inversion suggests no further movement.

Figure 3 represents the derivation of a subject *who*-question in Italian (*Who is sitting?*). Again, verb movement to T is necessary to acquire the relevant specifications; no further movement is necessary in *who*-questions. The crucial difference with respect to Figure 2 above concerns the movement of the subject *chi* ('who') to the specifier position of Q/FocP.




 Figure 3. *Who*-question derivation in Italian

The difference between the derivation of a *who*-question (Figure 3) and a yes/no-question (Figure 2) determines the difference in the degree of complexity as defined in Jakubowicz (2005). The Derivational Complexity Metric (4) determines that the complexity of yes/no-questions is lower than that of *wh*-questions, due to the higher number of Internal Merge/Movement operations in the latter.

However, it is to be noted that the two interrogatives involve the same higher projections: *wh*-elements move to the Q/Focus position in the left periphery, where yes/no-questions require a Q operator.

### 3.2. Wh-questions

As discussed in the previous section, *wh*-questions involve obligatory T-to-C movement, which makes these types of questions more complex than yes/no-questions in Italian. The complexity is determined via the Derivational Complexity Metric defined by Jakubowicz (2005), which takes into account the number of Internal Merge operations an element undergoes, and the number of elements involved in the reiterated Internal Merge operation.

However, experimental data concerning *wh*-questions suggest that the *type* of elements involved in the Internal Merge operation bear a weight as well. More specifically, an asymmetry in the comprehension and production of subject and object *wh*-questions across a range of different populations has been observed. It appears, in fact, that object *wh*-questions are somewhat more difficult than subject *wh*-questions, and differences arise even among different types of object questions. This has been observed in typical and atypical language acquisition (de Vicenzi, 1999, Avrutin, 2000; Friedmann, Belletti & Rizzi, 2009; Friedmann & Novogrodsky, 2011), in healthy adults (de Vicenzi, 1991) and in adults affected by acquired language pathologies, including aphasia (Hickok & Avrutin, 1996, Thompson et al., 1999; Grillo, 2008; Sheppard et al., 2015).

One explanation which accounts for these cross-populations patterns has been proposed by Friedmann, Belletti and Rizzi (2009). The authors observed that in object *wh*-questions, the object has to move across the subject. The derivation of these structures recalls the configuration described by Rizzi (1990) in exemplifying relativized minimality (RM) effects:

- (7) X .... Z ... Y

where X is the ‘target’ (e.g., the landing site of the *wh*-element), Z is said to be the ‘intervener’ and Y is the ‘origin’ (e.g., the External Merge position of the *wh*-element). If Z is an element which is similar to X, a local relation between X and Y cannot be established. In this case, Z is said to intervene between X and Y. Similarity is defined in terms of featural array and, more specifically, in terms of features which can trigger syntactic movement. Such features include +Q, which characterizes *wh*-elements, lexical +NP restrictions and, in raising analyses, a +R feature. While in adult comprehension it is enough for X and Z to differ with respect to one or more of the relevant features, Friedmann, Belletti and Rizzi (2009) observed that child comprehension is somehow stricter. If X and Z share as little as one feature, comprehension and/or production in children is affected.

Under this account, not all object *wh*-questions are equally difficult to process. Indeed, experimental results suggest that *who*-object questions (9a) are significantly less demanding than *which*-object questions (9b) in children aged 3 to 5 (Friedmann, Belletti & Rizzi, 2009: 78, examples from Hebrew):

- (8) a. *Et mi ha-xatul noshex?*  
ACC who the-cat bites  
‘Whom does the cat bite?’  
b. *Et eize kelev ha-xatul noshex?*  
ACC which dog the-cat bites  
‘Which dog does the cat bite?’

Two thirds of the children tested (aged 3;7-4;10) performed above chance on *who*-object questions while only four did so on *which*-object questions. The crucial difference is that in (9a) the target is not lexically restricted, hence X and Z do not share any relevant feature. On the other hand, in (9b) both the target and the intervener are lexically restricted, sharing a +NP feature:

- (9) a. *Who*-object questions:  
Wh Q . . . . . D NP . . . . . <Wh>  
b. *Which*-object questions:  
Wh NP Q . . . . . D NP . . . . . <Wh NP>

These data suggest that children’s computational resources may not be sufficient at the age tested to process an inclusion relation, exemplified in (10b).

The same constraints may hold true for aphasic speakers. Hickoc and Avrutin (1996), in fact, report similar data on the comprehension of *who*- and *which*- subject and object questions. The two participants, both diagnosed with Broca’s aphasia, performed above chance on *who*-questions, but results were asymmetrical with *which*-questions: while *which*-subject questions were well comprehended, participants performed at chance level with *which*-object questions.

The complexity of *wh*-questions can thus be characterized as follows:

1. *Wh*-questions are inherently more complex than yes/no-questions in Italian, as the former require movement of the *wh*-element to a higher projection, as well as T-to-C movement in *what/where/when*-questions. Both movements are absent in neutral yes/no-questions;
2. Subject *wh*-questions are less complex than object *wh*-questions, as in the former the subject moves without crossing any element potentially sharing its features;
3. Different degrees of complexity are available among object *wh*-questions.

Given this typology, it appears that a minimal comparison can be drawn between subject *wh*-questions and yes/no-questions. *Who*-subject questions appear to be the least complex *wh*-questions, as determined via the Derivational Complexity Metric (Jakubowicz, 2005) and the theory of Relativized Minimality (Rizzi, 1990). *Who*-subject questions, in fact, do not require T-to-C movement and the *wh*-element does not move across potential interveners. However, the degree of complexity of *who*-subject questions remains higher

than the degree of yes/no-questions, as the latter lack the T-to-C movement which all *wh*-questions in Italian involve.

### 3.3. Why-questions

The derivation of *why*-questions differs from that of other types of *wh*-questions (see e.g., Soare, 2021) and seems to be crucially less derivationally complex than argument (*who*, *what*) and adjunct (*when*, *where*) questions. This is due to two key differences between *why* and other types of *wh*-questions:

1. Similarly to yes/no-questions, neutral *why*-questions require a pre-verbal subject, which implies a lack of T-to-C movement of the verb;
2. The element *why*, contrary to all other *wh*-elements, originates in the left periphery.

*Why* has been cross-linguistically argued to occupy a position in the syntactic tree which differs from that of *wh*-items in other *wh*-questions. As proposed in Rizzi (2001), *why* targets a position in the tree which is higher with respect to that of other *wh*-elements, namely IntP:

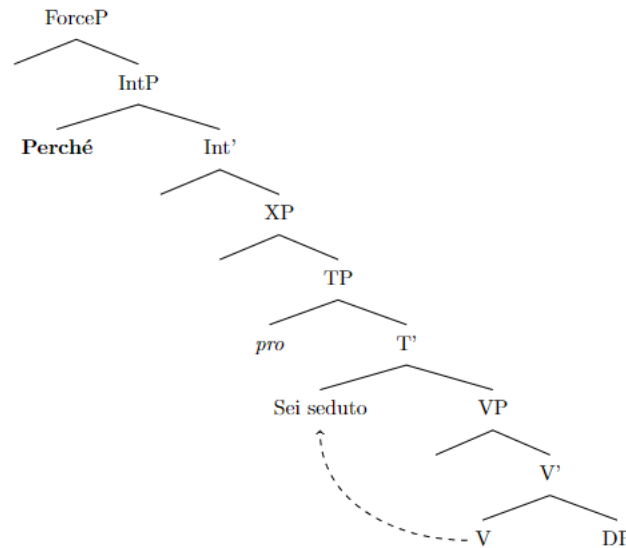


Figure 4. Why-question derivation in Italian

The Specifier of IntP selects operators which are Externally Merged there, as *perché* for *why*-questions in Italian and the interrogative *se* for indirect yes/no-questions. Subject and object *wh*-elements in *wh*-questions cannot be base-generated in the complementizer layer, as they need to be interpreted somewhere lower in the structure. Thus they reach the CP only via Internal Merge/Movement. Rizzi (1997) argued for this movement to target the Specifier of Focus Phrase, given the incompatibility between *wh*-questions and focalized elements. In *why*-questions, on the other hand, the elements *perché* and *se* can co-occur with a focalized element, suggesting that these two types of elements target different positions. Crucially, it has cross-linguistically been observed that the focalized element(s) must follow *why*, while the other way around is not allowed. Given that only one Focus Phrase is assumed in the complementizer layer (Rizzi, 1997), it follows that the projection in which *why* is generated must be a higher independent node.

The availability of data concerning *why*-questions in aphasia is limited but suggests a potentially preserved use of this type of questions. Garraffa (2003) reports a well-preserved use of *why*-questions in an Italian-speaking woman with agrammatic aphasia. Martínez-Ferreiro (2007) observed similar results in a study involving six Catalan-speaking aphasics, as *why*-questions in Catalan are at least superficially similar to Italian, insofar as they share the same word order.

In conclusion, in Italian, *why*-questions appear to be less derivationally complex than *wh*-questions, as they lack movement of both the verb and the *wh*-element. However, *why*-questions target a node (IntP) which is higher than the one targeted by *wh*-questions and the Q operator of yes/no-questions.

Given the structural and derivational differences discussed in these sections, it is clear how predictions would differ between a structural approach and a WM-limitation account. In the next section, predictions for the three types of interrogatives under study will be discussed.

### 3.4. Structural vs processing account predictions

According to the TPH (Friedmann & Grodzinsky, 1997), the successful comprehension and/or production of a structure can be predicted on the basis of the height of the nodes involved in its derivation. According to a WM-limitation account as in Jakubowicz (2005), it is the complexity of a structure which determines its successful comprehension and/or production. As discussed in section 3.1, neutral yes/no-questions in Italian require no T-to-C movement of the verb, as the position of the subject suggests. The same is observed in Hebrew, but not in English (see section 2.1). Assuming that the more complex a derivation is, the more resources it requires to be computed, it follows that yes/no-questions in Hebrew and Italian may be less resource-demanding than their English counterparts. Under a WM-limitation account, it would then be expected for production rates of yes/no-questions among Italian-speaking PWAgr to pattern with those of Hebrew-speaking PWAgr (Friedmann, 2002).

Under a structural account, however, yes/no questions in all languages should be comparable, as the highest projection involved in their derivation is Q/FocusP. Crucially, Q/FocusP is the highest projection involved in the derivation of *wh*-questions as well. Thus, under a structural account, there should be no difference between yes/no and *who*-subject questions. However, *who*-subject questions are more complex than yes/no-questions, due to the *wh*-movement in the former. Thus, under a WM-limitation account, yes/no-questions are predicted to be more easily produced than *who*-subject questions.

As for *why*-questions, given that the element *why* targets the highest portion of the tree, this type of question is predicted to be impaired in all cases of aphasia under a structural account such as the TPH. Under a WM-limitation account, on the other hand, no significant difference should be observed between the production of yes/no-questions and *why*-questions, given that the element *why* is Externally Merged in its high position. An asymmetry should thus arise between the production of yes/no-questions and *why*-questions compared to production of *who*-subject questions.

Table 1, repeated here, summarises the predictions which the two accounts make for each structure tested in the current study:

	Yes/No	Why	Who
<b>TPH</b>	×	×	×
<b>WM</b>	✓	✓	×

Table 2. Predictions: impaired (×) and preserved (✓) structures

Both accounts predict that *who*-subject questions will be impaired in Italian-speaking PWAgr. These types of questions, in fact, involve a high projection (TPH) and they are derivationally complex (WM). The two accounts diverge on their predictions concerning yes/no-questions and *why*-questions. According to the TPH, both questions should be impaired, as they involve high projections (Q/FocP, IntP). Under a WM-limitation account, on the other hand, yes/no-questions and *why*-questions should be produced at a significantly higher rate than *who*-subject questions, given their minimal derivational complexity.

## 4. Methodology

An elicitation task was employed to test the above discussed predictions. This follows the methodology employed in previous studies testing question production in PWAGR (Friedmann, 2002; Martínez-Ferreiro, 2007; Neuhaus & Penke, 2008; Burchert et al., 2015).

### 4.1. Participants

Three participants previously diagnosed with Broca's aphasia and one with (non-fluent, agrammatic) anomia were tested in an elicitation task. Participants were selected via the Italian Aphasic Association (*Associazione Italiana Afasici – A.IT.A.*) and all were tested in one session each, in a quiet room of their homes. Each experimental session began after informed consent was given. Non-pathological native speakers of Italian, matching in age and education, took part in the study to act as a control group.

### 4.2. Design and procedure

The design of the experiment closely patterns with Friedmann (2002). Three types of questions were elicited: yes/no-questions, *why*-questions and *who*-subject questions. No other types of *wh*-questions were included in this experiment, partly due to time constraints and partly to the derivational differences among other types of *wh*-questions discussed in paragraph 3.2. For the purpose of the current study, a comparison of the production rate of *who*-subject questions, along with yes/no-questions and *why*-questions was sufficient.

Twelve experimental stimuli for each of the three structures at hand were included. The experimental sessions were recorded and audios were later transcribed. Responses were judged as being either target-like or non-target-like.

The stimuli consisted of short sentences setting a context in which some piece of information was missing. The experiments were carried out with an assistant and participants were encouraged to ask this person questions about the missing information.

#### (10) Yes/No-question elicitation:

*Ho letto questo libro. Mi sembra che anche Maria l'abbia letto ma non ne sono sicura. Chiediglielo.*  
'I have read this book. I think that Mary has read it as well, but I'm not sure. Ask her.'

##### Target question:

*Hai letto questo libro?*  
have read this book?  
'Have you read this book?'

#### (11) Why-question elicitation:

*Maria è triste e vorresti sapere il motivo. Chiediglielo.*  
'Mary is sad and you would like to know the reason. Ask her.'

##### Target question:

*Perché sei triste?*  
why are sad?  
'Why are you sad?'

#### (12) Who-question elicitation:

*Qualcuno ha aperto la porta ma non sai chi. Lei lo sa. Chiediglielo.*  
'Someone opened the door, but you don't know who. She knows it. Ask her.'

##### Target question:

*Chi ha aperto la porta?*

who has opened the door  
'Who has opened the door?'

In addition to the twenty-four experimental stimuli, twelve fillers eliciting declarative sentences were included:

(13) **Filler:**

*C'è una finestra aperta. Vorrei dire a Maria di chiudere la finestra. Diglielo tu.*  
there-is a window open. Would tell to Mary to close the window. Tell-her-it you  
'There is an open window. I would like to tell Mary to close the window. You tell her.'

The sentences were read aloud and accompanied by pictures to set the context. No time limit was imposed on the task and participants could request to hear the stimuli as many times as they needed to. Participants were given the possibility to take breaks and to stop the experiment if they decided not to conclude it. Breaks excluded, experimental sessions lasted between 30 to 45 minutes per participant. In the control group, the task took on average 10 minutes to be completed.

## 5. Results

Correct responses were assessed on the basis of the following criteria:

- a) Responses had to consist of full utterances;
- b) Responses to experimental stimuli had to be given with an interrogative intonation.

Overall, few correct responses were produced. This was partly due to the severity of the pathology in the three participants, who were diagnosed with moderate to severe cases of aphasia.

	Who	Why	Yes/No
<b>R.B.</b>	0/12	0/12	4/12
<b>J.M.</b>	1/12	2/12	4/12
<b>L.C.</b>	0/12	0/12	3/12
<b>Total</b>	1/36	2/36	11/36

Table 3. Target-like production per participant.

Only one participant produced one *who*-subject question, entirely lacking in the other two participants. Yes/No-questions were instead produced by all participants, although at a low rate. One participant, J.M., produced two *why*-questions, while R.B. and L.C. were unable to produce this type of question. Hence, on a group level *who*-subject questions were correctly produced in 2.8% of the cases, *why*-questions were correctly produced in 5% of the responses given and yes/no-questions in 30.5% of the cases.

Participants in the control group performed well across conditions, although a difference emerged between *why*-questions, on the one hand, and yes/no-questions and *who*-questions, on the other. While yes/no-questions and *who*-questions yielded 94% and 92% correct answers respectively, *why*-questions yielded a much lower accuracy: 73%. The non-target-like productions in the control group include use of imperatives instead of questions, such as *Tell me who called me* instead of *Who has called me?*, and the use of indirect questions.

### 5.1. Error types

Among the non-target-like responses produced, both group and individual patterns can be identified. The most common error type consisted in the substitution of one type of interrogative with a different one. While this has been observed in all participants, question substitution totalled 50% of L.C.'s responses to *who*-question and *why*-question elicitation, e.g.:

- (14) *Ieri ha piovuto e la macchina si è sporcata. Qualcuno oggi ha pulito la macchina ma non sai chi. Lei lo sa, chiediglielo.*  
 'It rained yesterday and the car got dirty. Today, someone cleaned it but you don't know who. She knows it, ask her.'  
**Target answer:**  
*Chi ha pulito la macchina?*  
 Who has cleaned the car?

**L.C.'s answer:**  
*Francesca, hai pulito la macchina?*  
 Francesca, have you cleaned the car?

As these were substituted with yes/no-questions, it becomes clear that the overall production rate of yes/no-questions is much higher than what it appears to be if we only look at Table 2.

A common pattern among all three participants includes the production of declarative utterances instead of interrogatives. Declaratives are then sometimes followed by "yes or no?" in response to a yes/no-question stimulus, e.g. *Francesca, il cinema sì o no?* ("Francesca, the cinema yes or no?") or by a "question mark?" to convey an interrogative meaning to a declarative, e.g., *Francesca, due lavori... punto di domanda?* ("Francesca, two jobs... question mark?").

Incomplete utterances and false starts were observed as a frequent error pattern in one participant, J.M., for example:

- (15) *Chi è venuto alla ...*  
 Who came to the ...  
**Target answer:**  
*Chi è venuto a cena?*  
 Who came to dinner?

Although the adjunct is incomplete, the participant produced a complete *who*-question. At a group level, verb production proved challenging: when not completely omitted, verbs were produced in their bare form, with no tense morphology or with the wrong temporal specification. These patterns are however not surprising, as an impaired use of Tense has been independently known to be characteristic of this population (cfr. Friedmann & Grodzinsky, 1997; Faroqui-Shah & Thompson, 2007; Fyndanis et al., 2012, 2018).

## 6. Discussion

The results further confirm question production as an area of difficulty for agrammatic PWAGR. The main finding is that Italian speaking people with agrammatic aphasia show an asymmetry between the production of *who*-subject questions and yes/no-questions, with the former being severely impaired while the latter are better preserved. As both types of questions involve the high projection Q/FocP, this result is not compatible with the TPH. On the other hand, this result is expected under a WM-based approach, which takes into account the limited resources in this population and the derivational complexity of the elicited structures. This result in Italian is in line with the data available in Hebrew and Arabic (Friedmann, 2002)

while it contrasts what has been observed in English-speaking PWAgr. The near absolute lack of *who*-subject questions observed might appear unexpected, but this is likely linked to the severity of the pathology in the selected participants.

Contrary to expectations, *why*-questions were poorly produced by all participants. As the derivational complexity of this type of questions does not differ from that of yes/no-questions and is lower than that of *who*-subject questions, a WM-based approach cannot fully account for these results. On the other hand, a structural approach in line with the TPH (Friedmann and Grodzinsky, 1997) correctly predicts an impaired production of *why*-questions.

As yes/no-questions were overall produced at a higher rate, once substitution errors are taken into account, it does not seem that these participants are entirely lacking the CP, as is assumed under the TPH. However, results on *why*-questions elicitation suggest that the highest projections might be more vulnerable. As discussed in Hagiwara (1995), the highest functional projections are more likely to be impaired due to the higher number of applications of Merge. Hence, an approach that integrates both a structural and a WM-limitation account seems to best explain the patterns observed in this study. This could mirror proposals within the field of language acquisition as, e.g., the Truncation Hypothesis (Rizzi, 1993). The crucial aspect of the Truncation Hypothesis is that it assumes the structure to be developed in children, but optional truncation of the tree may result in some non-adult-like productions. The Truncation Hypothesis lends itself well to an integration of the two approaches so far discussed for aphasia, as it avoids the problems which the TPH runs into, without undermining the difficulties which the involvement of the highest nodes implies.

## 7. Conclusions

In this study, the production of three types of questions (yes/no-questions, *why*-question and *who*-subject questions) was tested in Italian-speaking PWAgr. In line with previous research (Friedmann, 2002; Chinellato, 2003), an asymmetry between *who*-questions and yes/no questions has been observed, with *why*-questions being overall poorly produced. These results cannot be explained straightforwardly by either of the two approaches discussed here, i.e. neither a structural nor a WM-limitation account are enough on their own to explain the observed patterns. Here, I have tentatively proposed to integrate the two approaches, as both the height of the projections involved in the derivation of the structures and their complexity appear to be relevant.

Overall, it is not possible to reach significant conclusions on the basis of the results obtained due to the limited number of participants in the experiment. A larger pool of participants, including people with mild aphasia, would crucially offer more data against which the theories discussed in this study could be tested.

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