Gender and number inflectional morphology in Italian agrammatic speakers: Further evidence for dual route models of processing

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This paper summarizes and discusses the results of several morpholexical and morphosyntactic experiments with two Italian patients who showed typical agrammatic features in speech production following neurological damage to the left cerebral hemisphere. Issues addressed in this study are whether the impoverished morphology in the patients' speech is due to impaired morpholexical functioning in general, to specific impairments in the lexical component responsible for regular inflectional morphology, or whether the apparent dysmorphology is the result of an impairment in syntax. The last hypothesis is supported by the data reported in this paper, and more particularly, the breakdown seems to occur if the appropriate morphological realization depends on a linking of thematic roles with coindices. A specific morpholexical impairment was also found with respect to compounds. It is obvious, however, that this impairment cannot account for all agrammatic phenomena in sentence production (e.g., selective impairment of function words).

1. Acquired language impairments and morphosyntactic disorders

Subjects who have acquired normal linguistic abilities can loose part of them after a focal brain lesion. The disorder is called aphasia and it usually follows a left hemisphere lesion. An aphasic language disorder may affect several linguistic components resulting in phonological, lexical-semantic, morpholexical and syntactic disorders, and it may involve several modalities, giving rise to impairment in oral and written production as well as in auditory and reading comprehension. Less frequently, a language disorder may be restricted to a single component in a specific modality. In the following, we will describe the major features of an aphasic disorder known as agrammatism with particular reference to the production of inflectional morphology.

2. Agrammatism

Agrammatism is generally described as a language disorder involving the morpholexical and morphosyntactic abilities of a

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patient while phonology and lexical semantics are relatively spared. The definitions of agrammatism given since its early descriptions (Pick 1913, Salomon 1914) usually stress aspects of spontaneous speech. Sentences are short, subordinate structures are missing, matrix clauses are reduced to communicatively essential elements, with a prevalence of nouns and the omission of function words, i.e., of prepositions, articles, auxiliaries, pronouns and conjunctions. Another feature frequently reported (Goodglass & Menn 1985) is the omission of bound morphemes such as inflectional endings. In languages like Italian, where open class elements are inflected also in the citation form, this would result in the production of non-word stems. However, Grodzinsky (1984) already showed for Hebrew that agrammatic patients do not generally omit inflectional endings but that, depending on the morphological structure of the target language, they substitute marked endings with less marked forms. Verbs occur in non-finite form, nouns in the singular, adjectives and participles (which in Italian agree in gender and number with the modified noun), are produced in the masculine singular default form.

2.1. Mechanisms underlying the agrammatic disorder

Since its first description by Pick (1898), the agrammatic symptomatology has attracted the attention of many aphasiologists, and several hypotheses have been proposed to account for the disorder.

(i) Some authors considered *agrammatism to be a pure performance disorder* which does not affect morpholexical and syntactic competence per se. There are two major accounts which refer to this kind of explanation:

The adaptation theory: Isserlin (1922) interpreted agrammatic production as a form of adaptive behavior to some kind of non-syntactic output disorder, leading the patient to maximally simplify his verbal production as an economy of effort. This hypothesis, which has been repeatedly reconsidered until the end of the early sixties (e.g. Lenneberg 1967), crucially predicts that syntactic comprehension is unimpaired.

The trade-off theory: Linebarger et al. (1983) suggested that agrammatism should be traced back to a general reduction of processing capacity. Due to this limitation, syntactic processing occurs at the expense of semantic processing and vice versa. The authors propose that in the case of agrammatism, morphosyntactic processing itself is unimpaired but due to overload it becomes deactivated in a

context with high semantic processing requirements, which may be the case in certain comprehension as well as production tasks.

(ii) *Agrammatism as a specific disorder for function words following a primary phonological or lexical disorder.* A first explanation that may be classed in this framework is the account proposed by Bradley, Garrett and Zurif (1980) of agrammatism as a lexical deficit for closed class elements (function words), which usually affects both production and comprehension. A selective processing deficit of function words has also been proposed by Kean (1977), who suggested that agrammatism was the consequence of a phonological processing disorder of unstressed elements such as function words and affixes.

(iii) *Agrammatism as a central disorder of grammatical competence.* This hypothesis, already suggested by Pick (1898) and also formulated by Bonhoeffer (1902) and Salomon (1914), among others, assumes a parallel involvement of production and comprehension caused by a single underlying grammatical deficit. This account has been restated in different forms during the last twenty years (Caramazza and Zurif 1976, Berndt and Caramazza 1980, Caplan and Futter 1986) and more recently in terms of a general loss of functional categories (Ouhalla 1991, 1993). Finally, Schwarz et al. (1980) and Saffran et al. (1980) propose that the agrammatic disorder originates at the lexicon-syntax interface and is the result of an impairment in mapping grammatical functions to thematic roles.

(iv) *Agrammatism as a selective damage within syntax.* More recent studies from linguistic aphasiology have explained agrammatism in the framework of Government and Binding Theory (Chomsky 1981), according to which syntax contains several representational levels and subsystems (linguistic modules). Damage to any of these syntactic modules could determine the outcome of specific and heterogeneous syntactic disorders. For instance, Grodzinsky's Trace Deletion Hypothesis (1986, 1990, 1991) suggests that agrammatism results from damage to a specific module required to assign the role of antecedent in a sentence. More recently, hypotheses on the treatment of inflection in agrammatism have been formulated within the framework of the minimalist program in linguistics (Chomsky 1993). For instance, Friedmann and Grodzinsky (1994) propose that tense, which is higher up on the tree, can be selectively impaired but not agreement, which is lower in the tree and its impairment would always also affect tense.

(v) *Agrammatism as a specific impairment within a sentence production model.* Some authors have proposed that agrammatism is the result of a selective impairment within a production model such as Garrett's (1980). In this model, two levels are postulated, a functional level in which the lexical elements are inserted, and a positional level which provides the closed class elements. Caramazza & Hillis (1989) suggested that agrammatism was the result of a specific impairment to the positional level. In Levelt's (1989) production model, on the other hand, agrammatism may be the result of a lexical impairment at the lemma level, of the disorder of syntactic procedures to construct phrases, or both. A lemma contains semantic and syntactic information of a lexical entry.

The syntactic information specifies among others the lemma's syntactic category, its grammatical gender, the argument structure of verbs, and a set of diacritic features such as case, person, number, tense. An underspecification of person, number, etc. may already take place at the lemma level during lexical processing, which will invariably lead to inflectional errors at the sentence level. On the other hand, inflectional errors may also be due to impairments in the sentence construction procedures themselves, since these involve the transfer of the diacritic features to NPs and VPs.

2.2. Deficit of inflectional morphology in agrammatism

As stated above, an impairment of inflectional morphology has been considered a salient symptom of agrammatism. However, the majority of the modern studies on this disorder were carried out with English speaking patients, a language with simple inflectional morphology which furthermore allows affixes to be dropped without producing nonwords. Indeed, English speaking agrammatic patients usually omit inflectional suffixes, but a generalization of this phenomenon to languages in which words bear an inflectional suffix also in their base form would result in the production of nonword stems. It was thus considered necessary to study morphological disorders of agrammatic patients in languages with more complex morphology.

Miceli and Caramazza (1988) described an Italian patient with agrammatic speech output (FS) who had a severe repetition deficit for inflected words and a milder impairment for derived words. They concluded that derivational suffixes were preserved whereas inflectional suffixes were almost inaccessible, and the patient substituted the target inflectional endings with less marked inflectional forms.

The authors explained the patient's performance by assuming differences in processing inflected and derived words, inflections being listed in the lexicon in decomposed form (and thus generated by the application of a morphological process), whereas derivations have lexical entries in a fully-listed form. The different organization would account for the patient's impaired repetition of inflected words and preserved repetition of derived words in the face of a morphological processing deficit.

However, the arguments developed by the authors do not take into account that the probability to make a derivational and/or inflectional error could be a function of the frequency of the affix or the number of possible alternatives. Furthermore, the error analysis conducted by the authors did not consider the productivity of the derivational suffixes. A general, non-specific disorder in processing affixes rather than an inflection/derivation dichotomy could also result in different rates of errors for derivational affixes. In Italian, derivational suffixes have no more than 2-3 possible alternatives, whereas inflectional affixes have a much larger number of possible alternatives, for instance, about 50 different inflectional endings for regular verbs. Correct repetition of derived forms thus has an a priori probability of 30% or more, whereas the chance occurrence of a correctly inflected form is considerably lower. A correct reanalysis of FS' data should thus take into account the frequency of the derived word, the frequency of the root, and the productivity and transparency of the derivational suffixes.

De Bleser and Bayer (1988) studied the morphological capacity of three German speaking agrammatic subjects and demonstrated normal ability of the patients in determining the grammatical gender of simple as well as derived and compound nouns, and in producing regular as well as irregular number inflection. The authors observed that patients were able to treat all morpholexical levels that had been tested (derivation, composition and inflection). However, their study of case-inflected noun phrases showed that morphology was only preserved as long as it did not have to be implemented in a syntactic frame. They concluded that agrammatic production was not so much the expression of "amorphology" but rather of "asyntaxia".

3. Gender and number inflection in Italian agrammatic patients

In the following, we will report the results obtained in a series of

experiments conducted with two Italian agrammatic patients (DR and MG). A first purpose of the study was to verify with Italian speaking agrammatic patients the results obtained by De Bleser and Bayer (1988) for German subjects. In order to do so, we tested the morpholexical abilities at the word level, i.e., the ability to assign gender and to realize number for simple, derived and compound nouns (Luzzatti and De Bleser 1996). Both patients showed an almost normal ability to deal with the regular Italian gender and number inflection system. Furthermore, we examined whether the two patients were able to implement this spared morpholexical knowledge in syntactic contexts of varying complexity (De Bleser and Luzzatti 1994). Given the relatively more complex system that governs gender and number inflectional morphology in Italian, it was possible to test the use of inflectional morphology more extensively than in the German study, as Italian requires gender and number agreement between nouns and adjectives and has an intricate system of rules governing past participle agreement.

The particular aims of the study can be summarized in the following questions:

1. At what level does the inflectional deficit of patients with agrammatic speech output originate, more specifically, is noun inflectional morphology already damaged at the lexical level?

2. If lexical morphology is only partially damaged, are there differences between regular and irregular inflection?

3. Are there differences in the processing required for gender assignment and number realization of simple, derived and compound nouns?

4. In the case of relative preservation of the component of lexical morphology which is relevant from a syntactic point of view (Anderson, 1982), i.e., of regular inflection, can this be implemented in a syntactic frame?

5. Can morphological deficits of agrammatic patients provide information on the nature of normal morphological processing, in particular, do the data from our patients support the following psycholinguistic hypotheses?

– in languages in which grammatical gender is not determined semantically and is not determinable unequivocally through the word ending, is this stored at some lexical-syntactic level (the lemma level in Levelt's (1989) model)?

– are regularly inflected forms for number (i) generated in the lexicon by the application of inflectional rules (full-parsing model),

(ii) listed at the lexical level (full-listing model) or (iii) produced either by a full access or a parsing route (dual-route model)?

– are there differences between languages with different grammatical mechanisms? For instance, is there any difference between English, a language with only natural gender and almost completely regular realization of the plural inflection, German, a language where assignment of grammatical gender and number realization is largely unpredictable but compound headedness is unambiguous, or Italian, a language where gender and number underly a general rule which, however, does not cover more that 2/3 of the nouns, and with near unpredictable headedness structure of compound nouns?

3.1. Noun inflection in Italian

Before describing the morpholexical abilities of the two Italian agrammatic patients who participated in the study, let us summarize the major features of the Italian inflectional morphology of nouns. In Italian, in contrast to English, all nouns, also those referring to non-living things, are grammatically specified for masculine or feminine gender, and neuter gender is absent from the system. Furthermore, articles are inflected for gender and number: *il* for masculine singular nouns (*lo* before [s] + consonant, [ʃ], [ts] and [ds]); *la* for feminine singular, *i* for masculine plural (*gli* before [s] + consonant, [ʃ], [ts] and [ds]) and *le* for feminine plural nouns, respectively, in the case of the definite article.

A further important difference to English is the fact that, with a few exceptions, simple Italian nouns are also inflected in the citation form. The system describing the regular Italian noun inflection can be summarized as follows: nouns with the suffix *-o* are masculine singular, *-a* feminine singular, *–i* masculine plural, and *-e* feminine plural. These simple textbook rules, however, do not account for the entire Italian gender and number system. First of all, many singular nouns end with an *-e* suffix, which is not specified for gender, e.g. *il ponte* (masc) 'the bridge', *il leone* (masc) 'the lion', vs. *la torre* (fem) 'the tower', *la tigre* (fem) 'the tiger'.

This relatively simple system of nominal inflection is further complicated by several factors:

(i) There is a restricted set of nouns originally coming from Greek (e.g. ***il poeta*** 'the male poet' or ***il dramma*** 'the drama') which have retained the *-a* ending of the source language in the singular

and are masculine (rather than feminine). These nouns take the regular masculine *-i* suffix in the plural (***i poeti***: 'the male poets').

(ii) Similarly, there are feminine nouns which originate from the ancient Greek and now have an untypical singular ending on *-i*. They remain invariant in the plural (e.g. ***la sintesi*** 'the synthesis'; ***le sintesi*** 'the syntheses').

(iii) There is a further set of nouns which are monomorphemic and their endings are not homophonous with existing Italian inflectional suffixes, so that their exceptional status is phonologically marked. A first invariant subset consists of feminine nouns which end on a stressed vowel (e.g. feminine singular: *la città* 'the town', feminine plural: *le città*). Furthermore, there is a set of invariant loan-words ending on a stressed vowel or on a consonant. With the exception of a few loan words from French that maintain the original feminine gender (e.g. *la brioche*), they all obtain masculine gender and are invariant in the plural form (e.g. singular: *il tunnel*, plural: *i tunnel*).

(iv) There is a restricted set of nouns which escapes all inflectional rules. One subset with a singular masculine *-o* ending changes its gender in the plural to feminine and takes the plural ending *-a*, which normally corresponds to feminine singular (e.g. singular: *il labbro* 'the lip', plural: *le labbra*; singular: *l(o)' uovo* 'the egg', plural: *le uova*). Two feminine nouns on *-a* retain their gender in the plural but change *-a* untypically to *-i* (singular: *l(a)' arma* 'the weapon', plural: *le armi*; singular: *l(a)' ala* 'the wing', plural *le ali*). Another subset has singular/plural pairs which are no longer morphologically transparent (e.g. *il bue* 'the ox', *i buoi*; *l(o)' uomo* 'the man', *gli uomini*).

As in other languages, grammatical gender in derived words is always determined by the derivational suffix. Therefore, morphological analysis per se allows regular gender identification. The only exceptions are a few cases referring to professions in which the derivational suffix is ambiguous for the masculine/feminine gender (e.g. *il fiorista* (masc) 'the male florist'; *la fiorista* (fem) 'the female florist'; *il/la dentista* (masc/fem), 'the male/female dentist').

For compound nouns, gender is determined by the grammatical head of the compound, which in its turn takes the appropriate inflectional ending for number. However, Italian differs from the large majority of the European languages in that the grammatical head of noun-noun compounds has no fixed position, as it may either be the rightmost element of the compound like in English and German or the leftmost element like in French.

Examples of English or German rightheaded compounds are:

(1a) [[[house]$_{neut}$] [[maid]$_{fem}$]$_{fem}$]; plural: [[[house]$_{sing}$] [[maids]$_{plur}$]$_{plur}$]

(1b) [[[*Haus*]$_{neut}$] [[*Tür*]$_{fem}$]$_{fem}$], house door; plural: [[[Haus]$_{sing}$] [[*türen*]$_{plur}$]$_{plur}$]

An example of a French left-headed compound is:

(2) [[[*bateau*]$_{masc}$] [[*mouche*]$_{fem}$]$_{masc}$]; plur: [[[*bateaux*]$_{plur}$] [[*mouche*]$_{sing}$]$_{plur}$]

Examples of Italian left- and rightheaded compounds are:

(3a) [[[*ferro*]$_{masc}$] [[*via*]$_{fem}$]$_{fem}$] 'railway', plural: [[[*ferro*]$_{sing}$] [[*vie*]$_{plur}$]$_{plur}$].

(3b) [[[*pesce*]$_{masc}$] [[*spada*]$_{fem}$]$_{masc}$] 'swordfish'; plural: [[[*pesci*]$_{plur}$] [[*spada*]$_{sing}$]$_{plur}$].

There is a further type of word-building that is used for the most productive compounding process in Italian, namely, Verb-Noun compounds:

(4) [[[*volta*]$_{verb}$][*faccia*]$_{fem.noun}$]$_{masc.noun}$] 'change of mind' (lit.: volte-face).

An example of the same pattern in English is:

(5) [[pick[$_{verb}$][pocket]$_{noun}$]]

The peculiar aspect of Verb-Noun compounds is that they are exocentric (headless) i.e. neither the verb nor the noun are head of the compound and the resulting composite form (a noun) has grammatical features which do not come from its composing parts. It is unclear which verbal form enters these compounds, the present third person singular, the imperative, or some variant of the stem (see Scalise (1984), p. 138, 147). When referring to objects, the grammatical gender of these compound nouns is almost always masculine (exceptions are: *la lavapiatti, la lavabiancheria*), irrespective of the gender of the noun entering the compound. Furthermore, the second element may be a plural noun, even in the singular form of the compound (see 6).

(6) [[[*porta*]$_{verb}$][*monete*]$_{fem.pl.noun}$]$_{masc.sg.noun}$] 'purse' (lit.: carry-coins)

3.2. Subjects of the experimental study

Two non-fluent aphasic patients were selected with prototypical "agrammatic" speech production. A major selection criterion was the

absence of marked articulatory disorders and/or phonemic paraphasias since this could make it difficult to judge the patients' output.

DR was a 27 years old dental technician who suffered three years earlier of a left cerebral hemorrhage after an aneurysm rupture. His spontaneous speech showed typical agrammatic features, as the following example shows.

Example of DR's spontaneous speech (from Luzzatti and De Bleser, 1996)

Examiner: Could you tell me the story of Little Red Riding Hood?

Cappuccetto Rosso (CR) ... *lupo* .... *CR* ... *CR* .. *eh* ..
Little Red Riding Hood (LRRH) ... wolf .... LRRH ... LRRH .. uh ..

girava (past tense, 3rd p.sg.) ... *no* ... *tutto* ... *eh* . *un* .. *non cosi, ma* ...
was walking around ... no ... completely ... uh . an .. not thus, but ...

(shows with hand: not in a curve, but the direct way)

diritto ... *scorciatoia* .. *e* .. *e* ... *un lupo* .. *lupo, eh non lo so, (..) e:* .."*salve!*"
straight... shortcut .. and .. and ... a wolf .. wolf, uhm I don't know (..) and: "Hello!"

(...) poi dopo .. *eh, poi dopo* .. *eh* .. *un lupo eh* .. *non so perché*..
(..) then afterwards .. uh, then afterwards .. uh .. a wolf uh .. (I*) don't know why

Examiner: Where does the wolf go to?

Lupo ... *n-nonna* .. *eh. Poi* .. *la bambina* ... *Eh* .. *spalanca* (pres.tense, 3rd p.sg.)
Wolf ... g-grandmother .. uh. Then .. the girl ... Uh .. (Subject*) makes wide open

e dice (pres.tense, 3rd p.sg.) ..
and (she *) says ..

Examiner: And she says?

eh .. *"gli occhi"* .. *poi* .. *"la* .. *la voce"* ... *e* .. *ah no!* .. *oh no!- però eh*
uh .. "the eyes" .. then .. "the .. the voice" ... and .. but uh (subject?*)
mangia (pres.tense 3rd p.sg.) ..*nonna* ..*mangia, no? Poi cappuccio*
eats ..grandma..(he*) eats, right? Then hood

(shows with hands that the previous utterances should be inserted here)

... *Poi* .. *e poi* .. *"grandi* (masc.pl.) *occhi* (masc.pl) *che hai"* (pres.tense, 2nd p.sg.) ..
...Then .. and then .. "large eyes that (you *) have"

e poi mangia ... . *Il cacciatore* .. *entra* (pres.tense, 3rd p.sg.) *e squarcia*
and then (subject?*) eats ... The hunter .. comes in and rips

la (fem.sg.) ... *la* (fem.sg.) ... . *Libera* (pres.tense, 3rd p.sg.) .. *la bambina e la nonna.*
the ... the ... . (He*) frees .. the girl and the grandmother.

* In Italian, subject pronouns are usually dropped, but verb endings generally indicate person and number.

MG was an 18 years old school boy. Two years earlier, while riding a bicycle, he was run over by a truck. The CT-scan taken one year post onset showed a large cortical-subcortical fronto-central-parietal area of hypodensity. The following transcription is an example of MG's spontaneous speech output.

Example of MG's spontaneous speech (from Luzzatti and De Bleser, 1996)

Examiner: Could you tell me the story of Adam and Eve?

Un giorno Eva ... *sull'albero* ... *sull'albero* ... *il serpente vede* .. *Eva* .. *Dice il serpente:*
One day Eve ... on the tree ... on the tree .. the serpent sees .. Eve .. Says the serpent:

"Ciao!.. prova . a mangiare .. la mela". "No, grazie.. perché.. Dio .. Dio .. non .. non ..
"Hi!.. try . to eat.. the apple". "No, thank you.. because.. God.. God.. (do) not.. (do) not ..

<Non mangiare!>. Non .. grazie, perché Dio ... non ... non .. non vuole Dio".
<Don't eat!>. Not .. thank you, because God ... not ... not .. (he*) doesn't want (it), God."

Il serpente: "prova, prova, prova..". A un certo punto Eva lo (masc.sg.; but, mela: (fem.sg.)
The serpent: "try, try, try ..". At a certain point Eve it

mangiò .. e .. "buono (masc.sg)*!" E .. Adamo: "Cosa hai .. fatto? Co-cosa fai?"*
eats .. and .. "good!" And .. Adam: "What have (you*) .. done? Wh-what are (you*) doing?"

No, niente .. Eh, Dio gridava; certo punto dice Dio: "Non.." Dio si .. si infuria
No, nothing .. Uh, God shouted; certain point says God: "(Do) not.." God becomes .. becomes furious

e allora .. punizione eh dice .. morto (past part.) ... *eh lei .. lui .. punizione.*
and then .. punishment uh (he*) says .. dead ... uh she .. he .. punishment.

* In Italian, subject pronouns are usually dropped, but verb endings generally indicate person and number.

Control subjects were 14 normal subjects (6 males and 8 females) from the same geographic area as the two aphasic subjects.

3.3. Noun inflection: knowledge of the grammatical gender and number realization

The ability to process gender and number inflectional suffixes was tested in DR and MG by means of different tasks:

(1) Gender assignment for (i) simple nouns that have regular masculine ending with *-o* and feminine ending with *-a*; (ii) derived

nouns in which the derivational suffix clearly determines the grammatical Gender; (iii) simple non-words ending with *-o* and *-a*; (iv) pseudo-suffixed non-words in which a non-word root had been derived by means of the same derivational suffixes used in task (ii); (v) right- and left-headed compound nouns. In this task, the examiner showed a written name and read it aloud. Patients were asked to orally repeat it by adding the gender-specific definite article.

(2) Number realization of (i) simple and (ii) right-headed, left-headed and exocentric compound nouns. The examiner produced the singular form of a noun and the patient had to generate the corresponding plural form.

Table 1. Predictions on the gender and number tasks

Predictions on the gender tasks:	
type of processing	*expected type of errors*
- lexical solution	no errors
- semantic solution	overgeneralization of incongruent cases e.g., *la spia* 'the spy'; *la sentinella* 'the sentinel'
- inflectional solution (-o =Masc; -a =Fem)	- overgeneralization of major rules e.g., Fem-*o* → Masc; Masc-*a* → Fem - no solution for ambiguous cases (*-e*=?).
Predictions on the number tasks:	
type of processing	*expected type of errors*
- full-listing lexical processing	no errors.
- full-parsing processing Sing → Plur	- overgeneralization of rules e.g., Fem-*o* → *-i*; Masc-*a* → *-e*. - no solution for ambiguous cases Masc-*a* → ? (*-a* or *-i* ?). - no solution for irregular forms e.g., *bue* → *buoi* 'ox → oxen'.

Table 1 summarize our prediction on the gender and number tasks. Tables 2-6 summarize characteristics of the items and the results obtained on the different gender and number tasks.

Table 2. Gender assignment in simple nouns: construction principles (from Luzzatti & De Bleser 1996, modified)

Sex	Morphological ending						Gender
	-o	*-a*	*-e*	CE	V^{l}	*-i*	
Male (n=25)	*il marito* (n=5)	*il poeta* (n=10)	*il padre* (n=5)				masculine (n=20)
		la sentinella (n=5)					feminine (n=15)
Female (n=10)		*la mucca* (n=5)	*la madre* (n=5)				
Neutral (n=40)	*il mondo* (n=5)	*il clima* (n=5)	*il paese* (n=5)	*il tunnel* (n=10)			masculine (n=25)
	la mano (n=5)	*la barca* (n=5)	*la nube* (n=5)				feminine (n=15)
Total (n=75)	(n=15)	(n=30)	(n=20)	(n=10)			

CE = consonant ending; V^{l} = stressed-vowel ending;
n = number of items for each category

Results

Type	Ending	N	DR	%	MG	%	C(%)
Determinable (following the major rule)	Masc.-*o*, Fem.-*a*	25	25	(97%)	25	(100%)	100
	consonant	10	9		10		99
Non-determinable	Masc./Fem.-*e*	20	12*	(60%)	19	(95%)	95
Irregular minor paradigms	Masc.-*a*,Fem.-*o*	20	11#	(55%)	19	(95%)	95
Total		75	57	(76%) ($p < .0001$)	73	(97%)	98

C = control subjects; * overgeneralization of *-e* = masculine; # regularization of *-o* = masculine, *-a* = feminine

Table 3. Results for the gender assignment task in derived nouns, simple non-words and pseudo-derived non-words. (a) For derived nouns the number of correct reactions is given; (b) for simple non-words there is no correct reaction but the more frequent response of control subjects is in bold face; for pseudo-suffixed non-words the number of correct reactions is given (from Luzzatti & De Bleser 1996, modified)

(a) DERIVED NOUNS

	DR	MG
Fem (15)	11	12
Masc (15)	15	15
Total	26/30 (87%)	27/30 (90%)

b) non-words

		DR		MG	
		reaction			
stimuli		*la* (=Fem)	*il* (=Masc)	*la* (=Fem)	*il* (=Masc)
simple	*-a* (n=10)	**7**	3	**9**	1
	-o (n=10)	0	**10**	3	**7**
pseudo-suffixed	Fem (n=10)	3		8	
	Masc (n=10)	8		7	

Table 4. Gender assignment to compound nouns (from Luzzatti & De Bleser 1996, modified)

(a) CONSTRUCTION PRINCIPLES

	Endocentric structure	
NN left-headed	*pesce / spada* 'sword fish'	(n=10)
NN right-headed	*la ferro / via* 'railway'	(n=10)
	Exocentric structure	
VN -a/-a	*il volta / faccia* 'volte-face'	(n=10)
VN -a/-o	*il segna / libro* 'bookmark'	(n=10)

(b) results

	DR	MG	C(%)
NN left headed (*pesce / spada*)	7/10	4/10	99
NN right headed (*ferro / via*)	7/10	9/10	96
Total correct NN	14/20	13/20	98
VN -a/-a (*volta / faccia*)	6/10	3/10	94
VN -a/-o (*porta / foglio*)	9/10	8/10	94
Total correct VN	15/20	11/20	94
Grand total of correct responses	29/40 (73%)	24/40 (60%)	96

Table 5. Plurals of simple nouns: (a) construction principles; (b) Results in terms of determinability by major rules (from Luzzatti & De Bleser 1996, modified)

(a)

Singular ending	Gender: masculine — Plural ending		Gender: feminine — Plural ending	
-a (n=30)	*-a:*	*gorilla* (5)	*-e:*	*chiesa* (5)
	-i:	*sistema* (10)		
-o (n=20)	*-i:*	*treno* (5)	*-o:*	*foto* (5)
stressed vowel (n=10)	- ˈV:	*sofà* (5)	- ˈV:	*città* (5)
consonant ending (n=10)	CE:	*foulard* (10)		
Irregular (n=8)		*dio → dei* *tempio → templi* *uomo → uomini* *uovo → uova* *dito → dita* *bue → buoi*		*ala → ali* *arma → armi*
n=78		n=51		n=27

(b Type

	Ending	N=	DR	MG	C(%)
Determinable (following the major rule)	Masc.*-o → -i* Fem. *-a → -e* Masc.*-a → -i*	40	40(100%)	39(100%)	99
Invariant	Masc./Fem.ˈV Masc. -CE Masc.*-a → -a* Fem. *-o → -o*	30	15*(50%)	28 (95%)	99
Irregular		8	3#(38%)	7 (88%)	94
Total (%)		78	58 (74%)	74 (95%)	99

*overgeneralization of the major-rule suffix (Masc.plur.-i; Fem.plur.-e);
regularization of Sing.-*o* and *-e* to Plur.-i and of Sing.-a to Plur.-e.

Table 6. Results on the number inflection of compound nouns.
ØØ, ØP, PØ, PP = no plural ending; plural in 1st, 2nd or 1st & 2nd position: correct solutions are framed (from Luzzatti & De Bleser, 1996, modified)

	Response: DR				MG				Controls (%)			
Target	ØØ	ØP	PØ	PP	ØØ	ØP	PØ	PP	ØØ	ØP	PØ	PP
- NN (n=20)												
e.g. *pesce/spada* 'sword/fish'	2	5	[3]	–	5	5	[–]	–	1	3	[87]	9
e.g. *ferro/via* 'railway'	2	[8*]	–	–	1	[8*]	–	1	4	[95]	–	1
- VN (n=10)												
e.g. *volta/faccia* 'volte-face'	[–]	4	–	1	[1]	4	–	–	[83]	17	–	–
e.g. *segna/libro* 'bookmark'	–	[5]	–	–	–	[5]	–	–	[11]	89	–	–
Total (30)	4	22	3	1	7	22	-	1	18	49	30	3
Total of correct responses:	16/30(53%)				14/30(47%)				91%			

* overgeneralization of the exocentric solution
(right headedness or no parsing of the compound).

Table 7 summarizes the results of patients DR and MG on the lexical-morphology tasks.

Table 7. Summary of the results for the patients dr & mg. Part 1: Lexical morphology

Experiment		DR	MG
Gender assignment:	simple nouns	– #,§	+
	non-words	+	+
	derived nouns	+	+
	pseudo-derived non-words	– §	+
	compound nouns	–	–
Number realization	(Sing → Plur): simple nouns	– °, *	+
	(Sing → Plur): compound nouns	–	–

+ = correct; – = impaired performance;
§ overgeneralization of masculine *-e*;
# regularization of masculine *-o* and feminine *-a*;
° regularization of irregular plurals;
* "regular" plural inflection of invariables forms

MG has near normal performance on gender assignment for simple and derived nouns, gender assignment for simple non-words and pseudo-derived non-words, and of number realization for simple nouns. Normal performance on these tasks presupposes direct lexical access, since a general application of regular inflectional rules would lead to regularization of irregular paradigms. On the other hand, MG's normal performance with non-words shows that regular inflectional parsing must also be preserved. In fact, MG has normal sensitivity to the grammatical features of regular inflectional morphology of simple and derived nouns. Notwithstanding the severely agrammatic spontaneous speech output with extremely poor production of inflectional morphology, there is thus no evidence of an impairment in the cued production of either regular or irregular inflectional morphology for simple and derived nouns.

However, MG is severely impaired with compound nouns, where he is unable to assign gender and to modify number. Normal performance on this task requires either full-listing processing or the appropriate parsing of the compound structure. MG seems to be unable to process compounds and treats them as simple nouns, extracting grammatical information only from the final ending of the compound, irrespective of the position of the grammatical head. This selective impairment of the morphological processing of compounds stands in strong contrast to MG's preserved morphological ability for simple an derived nouns.

Patient DR also shows a severe impairment in processing compound nouns. Like MG, he is unable to assign gender and to modify number and he treats compounds as simple nouns. However, DR's pattern of performance seems to differ from MG's concerning the production of inflections in simple and derived nouns. In general, DR cannot retrieve full-listing morpholexical knowledge, while his access to regular inflectional morphology for gender and number is spared. When processing simple nouns, he thus has to rely on regular inflectional rules which are overgeneralized to nouns with irregular paradigms.

DR and MG have in common that, although the set of morpholexical rules governing the inflectional morphology of simple and derived nouns can be used normally, there is a severe impairment for compound nouns. However, they differ with respect to the availability of direct access for irregular and unpredictable forms, which is preserved in MG and disturbed in DR.

3.4. Gender and number agreement in syntactic contexts

The purpose of the second part of the study was to test whether MG's and DR's spared ability to process regular gender and number

inflectional morphology could be implemented in syntactic frames of increasing complexity (Table 8). Table 9 summarizes the patients' performance on the different tasks.

Table 8. Grammatical agreement

(A) *Agreement in noun phrases (noun-adjective agreement)*

– article	+ article	
mano[$_{fem}$] pulit(**a**)	la mano[$_{fem}$] pulit(**a**)	(the) clean hand
poeta[$_{masc}$] famos(**o**)	il poeta[$_{masc}$] famos(**o**)	(the) famous male poet
ponte[$_{masc}$] strett(**o**)	il ponte[$_{masc}$] strett(**o**)	(the) narrow bridge
torre[$_{fem}$] bianc(**a**)	la torre[$_{fem}$] bianc(**a**)	(the) white tower

(B) *Agreement in sentences (participle agreement)*

(1) *Simple sentences*

ergative verbs (+ agreement)
La ragazza$_i$ è uscit(**a**)$_i$ dall'ufficio$_j$
'The girl has (lit.: is) left the office'

transitive active (– agreement)
La donnai ha baciat(**o**)$_j$ i genitori$_j$
'The woman has kissed the parents'

(2) *Complex sentences*

– AGREEMENT ACROSS CLAUSE BOUNDARY (OBJECT RELATIVE VS. COORDINATION)

object relative clauses
Il ragazzo$_i$ è andato dalla nonna$_j$ *che si* è ammalat(**a**)$_i$
'The boy has (lit.: is) gone to the grandmother who self is become ill (grandmother is ill)'

coordination
Il ragazzo$_i$ è andato dalla nonna$_j$ e si è ammalat(**o**)$_i$
'The boy has (lit.: is) gone to the grandmother and self is become ill (boy is ill)'

– SENSITIVITY TO NUMBER CUES

I quadri$_i$ che Anna$_j$ dipinse sono scompars(**i**)$_i$
'The paintings that Anna painted have (lit. are[plur]) disappeared'

I quadri$_i$ li$_i$ dipinse Anna$_j$ *e* sono scompars(**i**)$_i$
'The paintings them Anna painted and have (lit. are[plur]) disappeared'

– CONTIGUITY (reduced relative clauses)

La donna$_i$ *uscit*(**a**)$_i$ *dal ristorante ha chiamato i pompieri*
'The woman (who) left the restaurant has called the firebrigade'

La ragazza$_i$ *invitat*(**a**)$_i$ *al ballo ha perso una scarpa*
'The girl invited to the ball has lost a shoe'

- DIRECTION OF AGREEMENT (right to left); absolute relative clauses

ergative
Mort(**a**)$_i$ la reginai, i sudditi piansero tutto il giorno
'Died the queen, the citizens cried the day along'

transitive passive
Consegnat(**a**)$_i$ la posta$_i$, i portalettere lasciarono l'ufficio
'Delivered the mail, the mailmen left the office'

Agreement inside a Noun Phrase. In Italian, adjectives are inflected for gender and number and they agree with the noun they modify, usually in postnominal position. We examined DR's and MG's ability to realize Noun-Adjective gender and number agreement in a simple Noun Phrase (Luzzatti and De Bleser, 1996, Experiment 2). Stimuli were presented in written form. Each noun was followed by an adjective of which the inflectional ending was substituted by dots. The examiner read each stimulus aloud: patients had to supply the inflected form of the adjective. In the absence of explicit gender information in the stimulus material, DR reproduced the pattern of errors of the gender assignment task described above, whereas the performance of both subjects was flawless when the stimulus material contained a definite article expressing the grammatical gender of the noun.

Agreement in simple sentences. Syntax-relevant morphology was investigated by means of past participle agreement. The Italian past participle of regular verbs consists of the verbal root followed by the participle suffix *-t,* followed by a vowel ending. The unmarked, non-agreeing form ends in *-o,* whereas the agreeing inflectional suffixes are *-o* (masc., sing.), *-a* (fem., sing.), *-i* (masc., plur.) and *-e* (fem., plur.). At first glance, the system is quite heterogeneous, since the past participle agrees in some cases with the subject, in others with the direct object, and in some further cases there is no agreement with any element of the sentence. This variability is expressed in the following descriptive rules: (i) there is no agreement with intransitive verbs, which always require the auxiliary verb *avere* (to have) (7); (ii) there is agreement in Gender and Number with the subject of ergative verbs, which always require the auxiliary *essere* (to be) (8), (iii) there is no agreement in the case of active transitive verbs when the object is a full NP (9), whereas (iv) there is Gender and Number agreement with the object if this is a clitic pronoun in pre-verbal position (10). Finally, (v) there is agreement with the surface subject of the sentence in transitive passive sentences (auxiliary: essere) (11).

(7) *Maria ha telefonato* (ø)
'Maria has telephoned'

(8) *Maria è arrivata in ufficio*
'Maria has (lit.: is) arrived to the office'

(9) *Maria ha baciato (ø) due ragazzi*
'Maria has kissed two boys'

(10) *Maria li ha baciati*
'Maria has kissed them' (lit.: 'Maria them has kissed')

(11) *Due ragazzi sono stati baciati da Maria*
'Two boys have (lit.: are) been kissed by Mary'.

This complex set of descriptive rules can simply be captured by the general principle (Burzio, 1987, pp.53-56) that the past participle agrees in gender and number with an element holding a binding relation with the direct object (i.e., a passive subject, an ergative subject, or a clitic object in preverbal position).

Agreement in complex sentences. In order to assign the correct participle agreement in complex sentences, it is necessary to parse the entire structure of the sentences. This is especially the case when agreement has to refer to a coindexation across a clause boundary (see Table 8, B2).

Patients DR and MG were given different types of sentences in which the past participle appeared in non-inflected form (the final vowel was missing) and had to supply the full form of the participle (see De Bleser and Luzzatti 1994). Table 9 summarizes the different types of sentences given to the patients and the results obtained.

Table 9. Summary of the results for tha patients dr & mg. Part 2: Grammatical agreement

Agreement in a Noun Phrase (see Luzzatti & De Bleser, 1996)

	DR	MG
Noun-adjective agreement	+	+

Agreement in sentences (see De Bleser & Luzzatti, 1994)

Experiment	DR	MG
Simple sentences: extended NP		
ergative verbs (agreement +)	+	+
transitive active (agreement –)	+	+
Simple sentences: clitic pronoun		
direct object (agreement +)	+	– §
indirect object (agreement –)	+	+
Complex sentences: discrimination between		
coordinate sentences	–	–
object relative sentences	–	–
Sensitivity to number cues in parsing:		
simple sentences	+	+
complex sentences	+	+
Contiguity:		
subject relative clauses	+	+
reduced relative clauses	+	+
Direction of agreement:		
absolute relative clauses (dx → sn)	– §	–

+ = correct; – = impaired performance.
§ Errors are mostly *-o* inflections (ø agreement).

Results show that both patients mastered the general principles governing participle agreement in simple sentences (verb class and auxiliary). DR also has a normal sensitivity to direct-object clitics and their movement, while MG had minor problems with agreement with the direct object clitics (in the case of incorrect responses, he either selected an unmarked form (*-o*) or copied the features from the subject position). Both patients, however, failed when they had to implement their spared inflectional morphological knowledge into a complex syntactic frame, in particular when correct agreement required coindexation with an explicit element outside the clause boundaries but two NPs were available as possible, non-structural-driven antecedent for gender and number agreement.

In summary, the results obtained by DR and MG seem to contradict the hypothesis that agrammatic spontaneous speech is the expression of a selective impairment of lexical inflectional morphology. On the contrary, a morphological deficit only appears when regular inflection has to be implemented in a rather complex syntactic context. It is interesting to note that both DR and MG showed a lexical morphological deficit especially for compound nouns, the lexical subcomponent in which syntactic principles (headedness) are involved.

From a psycholinguistic point of view, the data support such processing models that incorporate a lexical decomposition and assembling routine in addition to a full listing routine. With reference to the lexical model proposed by Levelt (1989), damage of the lemma should lead to an impairment of the grammatical knowledge of words such as grammatical gender and irregular inflectional paradigms. The realization of regular inflectional morphology, however, takes place at a more peripheral lexical level (the lexeme, i.e., the morphophonological word form) or in interaction with a syntactic operation. In our patients, and especially in DR, these operations seem to be unimpaired.

4. Morphosyntactic disorders in developmental language deficits

It is interesting to compare the morphosyntactic disorders observed in both of our patients, and especially in DR, to the developmental morphosyntactic deficits described by Gopnik and Crago (1991) in an English speaking Canadian family with a hereditary linguistic impairment. 16 out of 30 members of the family had a developmental

language disorder, which was not associated with deafness, mental retardation or neurological impairment. During the first decade of life, speech was almost unintelligible due to a severe phonological disorder, but phonological output improved progressively revealing a clear damage of morphosyntactic abilities, which in turn showed a progressive improvement during the following decades. The spontaneous speech of the elderly subjects of the family appeared almost normal, but in specific tasks, the persistence of a severe impairment of grammatical competence could be demonstrated.

Gopnik and Crago tested the subjects using an extensive set of tasks for the evaluation of morpholexical and morphosyntactic abilities (see table 10) similar to those we used for our agrammatic patients.

Table 10. Summary of the performance of pateints with developmental language disorders (Gopnik and Crago, 1991)

Tasks	Performance
1) comprehension of simple clauses (grammatical number)	+
2) comprehension complex sentences	+
3) syntactic comprehension (pronouns, reflexive pronouns, negation, active/passive, word order)	+
4) comprehension of stories	+
5) inflectional morphology (number, person, aspect):	
– grammaticality judgements	–
– correction of errors	–
6) plural realization of non-words	–
7) derivational morphology (realization of derived adjectives)	–
8) irregular verb paradigms (go → went)	±
9) thematic roles (grammaticality judgements)	+
(correction of errors)	–
10) analysis of written texts: irregular past tenses	+
regular past tenses	–

Overall, the subjects' performance showed a clear pattern of impairment that can be summarized as follows:

(1) The subjects were able to perform tasks requiring the production of regular and irregular plurals, but they were not able to generate plurals of non-words. This pattern of impairment indicates that they distinguished singular from plural forms as non-parsed independent lexical elements rather than as the result of a morphological

rule that allows the generation of a plural of an English noun from the singular by adding the inflectional suffix *-s*;

(2) The subjects showed a similar pattern of impairment also in modifying verb tenses. They were quite insecure in retrieving regular and irregular past tenses from a present form, though irregular forms were more frequently correct than regular ones. Once an error was pointed out by the teacher or by the speech pathologist, subjects were able to learn irregular as well as regular past tenses, but they were not able to generalize the regular paradigm to other verbs. This pattern of impairment indicates that subjects learned each past tense as a new lexical item but did not learn the rule that allows to generate past forms of new verbs. Such a full listing procedure requires 30 to 40 years instead of the usual 3 to 4 years required to learn and apply the rules;

(3) Subjects were then asked to generate adjectives from nouns by adding a derivational suffix (e.g., man-ly). As in the inflectional tasks, they showed an extreme difficulty in applying derivational rules to obtain derived adjectives.

In conclusion, the pattern of performance observed in these patients indicates that learning of morphologically complex (inflected or derived) forms was purely based on a full listing lexical procedure, i.e., without the acquisition of inflectional or derivational rules, in contrast to normal subjects. Thus, Gopnik and Crago's subjects had to learn each regular derived and/or inflected word as an independent item and store it in a lexicon that specifies the grammatical properties individually for each single item. The subjects of the family, therefore, suffered from a selective inability to learn grammatical rules, which was genetically determined.

4.1. Comparison between morphosyntactic disorders in agrammatism and developmental language disorders

The striking differences in the results obtained by Gopnik and Crago (1991) on genetic cases of developmental morphological disorders and those obtained from patient DR call for a comparison of the data (Table 11). In fact, they show opposite patterns of performance. Given the differences between Italian and English morphology and the partial differences of the tasks used in our and in Gopnik's study, such comparison must obviously be taken with caution.

DR easily solved the tasks requiring the application of morpho-

lexical rules and – with some restriction – of morphosyntactic rules, whereas he was completely unable to access irregular inflectional paradigms, usually overgeneralizing the morphological rules and regularizing irregular paradigms.

Table 11. Comparison of morphosyntactic impairment in patient DR and in developmental language disorders (Gopnik & Crago, 1991)

Tasks	Performance	
	DR	DLD
regular noun inflection	+	±
regular verb inflection		±
plural realization of non-words	+	–
derivational morphology (realization of derived adjectives)	+	–
irregular paradigms (nouns)	–	±
irregular paradigms (verbs)		±

± = subjects learn regular and irregular forms with similar difficulty

The developmental subjects described by Gopnik and Crago (1991) showed the opposite pattern of impairment, being able to perform successfully only on those tasks which can be processed by full-listing lexical knowledge and not on the tasks requiring the application of morpholexical and syntactic rules. It would thus seem that morpholexical rule acquisition has a modular, genetically predisposed basis.

5. Conclusion

Crosslinguistic studies on agrammatism and other language disorders are essential to verify linguistic and psycholinguistic theories. In particular, due to its very simple word morphology, studies on English seem to be little appropriate to test theories on the normal processing of lexical morphology. The results of a neurolinguistic study with two Italian patients showed that neither of the two subjects support the hypothesis that morphology by itself is generally impaired in patients with agrammatic spontaneous speech.

An impairment of some selective morphological aspects had been already suggested by Miceli and Caramazza (1988) for patient FS, who showed, at least in a repetition task, an apparent dissociation between poor inflectional but less impaired derivational processing.

The results obtained in our study indicate that for languages in which grammatical gender does not necessarily correspond to the natural one, gender information must be coded at the lexical level (e.g., Levelt's lemma level). Furthermore, with regard to the realization of singular / plural paradigms in languages with unpredictable number realization, subjects must have access to full-form representations (Butterworth 1983), whereas regularly inflected plurals of unknown words or of nonwords necessarily rely on a parsing route. Such dual-route processing models of lexical morphology have been proposed in several psycholinguistic studies based on lexical decision tasks in normal subjects (e.g. Burani & Caramazza 1987, Burani & Laudanna 1992, Baayen, Dijkstra & Schreuder 1997). The data from our patients on different tasks tapping inflectional morphology at the lexical level support such models. Especially in the case of DR, there is a strong dissociation between the preserved use of morpholexical rules and impaired full-listing procedures. Furthermore, the spared processing along both routines observed in MG shows that a selective impairment of either routine cannot be considered as a prerequisite of agrammatic spontaneous speech output.

With respect to compound processing, there seems to be a difference, at least numerically, between the processing of gender and number, especially in the case of DR. Whereas he tends to realize number word externally, irrespective of the compound structure, his performance in the gender assignment task shows at least some awareness for the structure of the compound word and the gender of its head.

The difference between gender and number for compounds may reflect a different type of processing that has been suggested for these grammatical features (see other articles in this issue). Gender is a feature which, in Italian at least, is clearly localized at the Lemma level and has its own node at this level comparable to word category (Levelt 1989); Number, however, is a mere diacritic feature at this level and must be realized at the Lexeme level. To assign gender and realize number should thus be dissociable functions. Number realization can be regular or irregular, the irregular obviously underlies a lexical processing in full-listing, the regular one may be in full-listing and/or be generated by the application of inflectional rules. Noun-adjective agreement inside an NP (for those languages like Italian where adjectives take gender and number agreement with the corresponding noun) or participle agreement in simple and complex sentences underly coindexation rules that are likely to be the same for gender and number. The different nature of gender and number

processing, which was only indicated in this study on agrammatic subjects, is the object of a further study that is in progress on a larger sample of agrammatic patients.

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