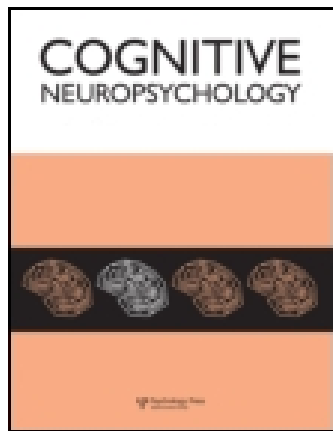


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Patrizia Tabossi ^a, Simona Collina ^b, Alessandra Caporali ^c, Fabrizio Pizzioli ^d & Anna Basso ^e

^a University of Trieste, Trieste, Italy

^b Università degli Studi Suor Orsola Benincasa, Naples, Italy

^c University of Milan, Milan, Italy

^d Université Catholique de Louvain, Louvain, Belgium

^e University of Milan, Milan, Italy

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Speaking of events: The case of C.M.

Patrizia Tabossi

University of Trieste, Trieste, Italy

Simona Collina

Università degli Studi Suor Orsola Benincasa, Naples, Italy

Alessandra Caporali

University of Milan, Milan, Italy

Fabrizio Pizzioli

Université Catholique de Louvain, Louvain, Belgium

Anna Basso

University of Milan, Milan, Italy

C.M. is an agrammatic patient who on assessment tests shows a disproportionate difficulty when producing verbs compared with nouns. In three experiments, we investigated whether C.M. also has difficulties with nouns referring to events and whether event nouns and verbs show similar patterns of disruption. Experiment 1 suggested that she is sensitive to argument structure complexity and has a greater impairment in the production of event nouns and verbs than object nouns. Experiment 2 revealed that C.M. finds derivationally complex words, such as event nouns, difficult to produce. However, morphological complexity does not completely explain C.M.'s problems with event nouns. In Experiment 3, an assessment of C.M.'s ability to use different aspects of semantic and syntactic knowledge relative to event nouns and verbs showed an almost identical performance with the two types of words. The relevance of the findings with respect to models of word production is considered.

Keywords: Noun/verb dissociation; Event words; Word production.

Correspondence should be addressed to Patrizia Tabossi, Department of Psychology, University of Trieste, Via Sant' Anastasio 12, 34134 Trieste, Italy (E-mail: tabossi@units.it).

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This study explores the ability of an Italian agrammatic patient, C.M., to produce and comprehend words that denote events. Typically, events¹ are referred to by means of verbs.

A range of theories have been developed by linguists to explain how verbs are organized and how their semantic and syntactic properties can best be captured (Chierchia & McConnell-Ginet, 1993; Goldberg, 1995, 2006; Grimshaw, 1990; Jackendoff, 1990, 2002; Levin, 1993; Pinker, 1989).

At present, there is general consensus that a verb must possess a “core” meaning: what linguists often refer to as its “root”. For example, the core meaning of a verb like *to destroy* could be something like “breaking into pieces” (Oxford English Dictionary, 2008). Also, since verbs are predicates of events, a crucial part of their meaning is the specification of the participants in the event. Although various theories have been proposed (see Levin & Rappaport Hovav, 2005, for a review), the simplest and probably the most commonly adopted form of representation of this aspect of verb semantics is the semantic role list (Fillmore, 1968; Gruber, 1965; Jackendoff, 1972, 1976). According to this view, each verb is associated with a list of semantic roles, which specify the part that the verb’s arguments play in the event denoted by the verb. For example, the thematic grid of *to destroy* would include an agent (the destroyer) and a theme (the entity being destroyed).

Syntactically, in addition to the specification of the grammatical category, crucial information is contained in a verb’s argument structure—that is, the number of arguments associated with it. For example, *to destroy* has two arguments that need to be expressed for a sentence to be grammatically acceptable (e.g., *John destroyed the car* vs. **John destroyed*). Moreover, the appropriate use of a verb requires the knowledge of the types of complement by means of which arguments are realized—that is, the specification of its subcategorization frame(s): The verb *to destroy* is a transitive verb and requires a subcategorization frame with a direct object (e.g., *Peter destroyed the*

toy); a sentence with a different complement would be incorrect (e.g., **Peter destroyed with the toy*; Breedin & Martin, 1996).

Although most linguists agree that the syntactic realization of arguments is predictable to a large extent from meaning, there is no consensus on what specific aspects of meaning are most critical. Moreover, while according to some authors subcategorization information need not be explicitly represented, as it may be entirely derived from semantics (Pinker, 1989; Radford, 1988), other researchers are more cautious on this point (Jackendoff, 2002).

Traditionally, the various types of information relative to a verb have been assumed to be represented in the lexical entry of the verb. However, a number of considerations have led some authors to hypothesize that our knowledge of the language includes constructions—that is, “form-meaning correspondences that exist independently of particular verbs” (Goldberg, 1995, p.1). Subsets of these constructions are argument structure constructions. For example, an important argument structure construction in English is the ditransitive construction, as in “*Tim sold Pete the car*”. The construction is something like
X CAUSES Y TO RECEIVE Z Subject Verb Object Object.
In order to specify a syntactic frame, the construction has a meaning “involving successful transfer of an object to a recipient, with the referent of the subject agentively causing this transfer” (Goldberg, 1995, p. 33).

In this perspective, a verb’s lexical entry does not contain information about its argument realizations. Rather, it has connections with the various constructions it can enter. Its lexical representation is assumed to maintain information about its thematic grid, but these roles (participant roles) are kept distinct from the roles associated with constructions (argument roles). To use the verb, the participant roles and the argument roles must be fused, and in order for this fusion to succeed—and hence for an appropriate sentence to be produced—the participant roles must be compatible

¹ *Event* is used here to refer in a general fashion to processes, states, or events alike.

with the argument roles specified by the construction in which the verb occurs.

Clearly, verbs are very complex linguistic objects, and, as neuropsychological research has successfully shown, they present special difficulties to some aphasic patients. Specific problems with verbs are often associated with agrammatism (Miceli, Silveri, Villa, & Caramazza, 1984; Schwartz, Linebarger, & Saffran, 1985; Zingeser & Berndt, 1990), even though neither do all agrammatic patients show a selective verb deficit (Berndt, Mitchum, Haendiges, & Sandson, 1997), nor is the deficit restricted to them (Berndt et al., 1997; Caramazza & Hillis, 1991, Daniele, Giustolisi, Silveri, Colosimo, & Gainotti, 1994; Hillis & Caramazza, 1995; Zingeser & Berndt, 1990).

Verb difficulties are most commonly observed during production (Caramazza & Hillis, 1991; Rapp & Caramazza, 1998a, 1998b; Silveri & Di Betta, 1997). However, some studies have reported patients whose performance with verbs was impaired in comprehension as well as in production (McCarthy & Warrington, 1985; Saffran, Schwartz, & Marin, 1980).

All the different types of knowledge discussed by linguists may be disrupted. For example, Barde, Schwartz, and Boronat (2006) found that a group of agrammatic patients had a larger decrement in the production of lighter verbs (i.e., verbs that have fewer semantic components) than in the production of verbs that have greater semantic weight. In a similar vein, Breedin, Saffran, and Schwartz (1998) investigated the role of semantic complexity (i.e., number of semantic features) in verb retrieval in a group of patients with a selective impairment in verb processing and found that most of patients were better at retrieving semantically complex verbs (e.g., *run*) than semantically simpler verbs (e.g., *go*).

In addition to problems with the core meaning of verbs, difficulties with thematic role assignment have also been reported. Byng (1988) described two patients who had no difficulties in understanding the meaning of verbs, but were unable to map the syntactic complements of a sentence into the thematic roles specified by the verbs.

Schwartz and coworkers (Schwartz, Saffran, & Marin, 1980) found that agrammatic patients had a special difficulty at mapping a verb's thematic structure onto its appropriate syntactic frame, both in production and in comprehension, and that the problem remained even when they retained the ability to judge the grammaticality of a sentence (Linebarger, Schwartz, & Saffran, 1983).

Syntactic effects—in particular, effects of argument structure—have been reported in many languages (Kim & Thompson, 2000; Luzzatti et al., 2001; Thompson, Lange, Schneider, & Shapiro, 1997). For example, Kim and Thompson (2000) reported agrammatic patients who were more accurate in naming/categorizing one-place verbs than two-place verbs and more accurate in naming/categorizing two-place verbs than three-place verbs, showing a hierarchy of verb difficulty.

Aspects of semantic/syntactic knowledge may be selectively impaired in brain-damaged patients. Breedin and Martin (1996) examined four aphasic patients who showed different patterns of verb disruption. P.W.'s performance suggested that her knowledge of both thematic roles and subcategorization frames was damaged, the former being more severely impaired than the latter. Multiple deficits were also shown by J.S., whose behaviour suggested a disruption of subcategorization frame knowledge along with a loss of the ability to discriminate semantically related verbs with multiple arguments. The other two patients both showed selective semantic difficulties, but the nature of their deficits differed. V.P. appeared to have a loss of the core meaning of some verbs, while retaining the ability to assign thematic roles. In contrast, L.K. maintained knowledge of core meaning, but his ability to assign thematic roles was seriously disrupted.

Objects and events

Verb impairment is one side of a well-known double dissociation, the other side of which is constituted by a selective noun deficit (Miceli, Silveri, Nocentini, & Caramazza, 1988; Miceli et al., 1984; Rapp & Caramazza, 1998a; Silveri & di Betta, 1997; Zingeser & Berndt, 1988, 1990).

Typically, the disproportionate difficulty exhibited by some aphasic patients with verbs along with the opposite difficulty shown by other patients with nouns is interpreted as grammatical class impairment, selectively affecting either nouns or verbs (Caramazza & Hillis, 1990, 1991). So far, this view has provided a more convincing explanation for the double dissociation than alternative hypotheses aimed at reducing the grammatical class distinction to more general differences (Allport & Funnell, 1981; Joannette & Goulet, 1991; McCarthy & Warrington, 1985). For example, many patients have better performance with high- than low-imageability words. But nouns tend to be more imageable than verbs, and, if overlooked, this difference may introduce a confound that can lead to the erroneous interpretation of a semantic effect as one of grammatical class (Allport & Funnell, 1981). However, patients with no impairment in the processing of abstract words can nonetheless show poor performance on verb production (Caramazza & Hillis, 1991).

Most studies conducted to investigate the noun/verb dissociation use object nouns—that is, words that, in addition to grammatical class, differ from verbs in other potentially relevant aspects. As noted above, in addition to the core meaning and the specification of grammatical class, unlike object nouns, verbs require several other pieces of semantic and syntactic information, and this disparity, rather than the category difference per se, might explain some putative selective grammatical class impairments.

However, there are nouns that refer to events and have most of the semantic and syntactic features typically associated with verbs. *Destruction*, for example, is an event noun; more precisely it is a verb-centred nominalization morphologically derived from *to destroy*. Its meaning includes a core that is the paraphrase of the verb meaning—that is, something like “the event of breaking to pieces”—and a thematic grid that is

the same as that of the verb—namely, agent and theme. Syntactically, *destruction* is a noun, but has the same argument structure of the verb it is derived from².

Unlike thematic grids that are the same for event nouns and corresponding verbs, syntactic forms are different. The most obvious difference is that verbs' subcategorization frames include noun phrases (NPs), whereas the arguments for an event noun must be expressed by prepositional phrase (PP) constructions, and at least one of the arguments is expressed by a PP headed by *di/of* (Italian and English, respectively). In some cases, the arguments marked as nominative and accusative by the corresponding verbs can both be introduced by *di/of*. In *the description of Mary*, for example, *of Mary* is ambiguous as it can express the subject or the object of *to describe*. However, there are nouns that are the heads of NPs where the *di/of*-phrase unambiguously introduces either the subject (e.g., *combattimento/fighting*) or the object (e.g., *ferimento/wounding*) of the corresponding verb.

In spite of these differences, there are systematic correspondences between the structures projected by verbs and the structures projected by their verb-centred nominalizations. For example, if a verb's subcategorization frame includes a prepositional phrase (e.g., *He fled from our country*), the same phrase appears as a complement of its nominalization (e.g., *his flight from our country*; Castelli, 1991). These correspondences have led some researchers to suggest that the subcategorization frames of a noun may be generated from those of the corresponding verb as a consequence of its combination with the nominal suffix (Chomsky, 1970).

Commonalities between event nouns and verbs have been shown experimentally by Vigliocco, Vinson, Lewis, and Garrett, (2004). In a picture-naming study, participants were presented with pictures representing events (e.g., swimming) along with distractor words that were either

² Arguments are obligatory for nouns as well as for verbs. When they are not expressed they are retrievable from context (Graffi, 1990).

semantically related or unrelated to the target (e.g., “swimming”) and were either verbs or nouns. The findings showed that producing the target took longer in the semantically related than the unrelated condition, suggesting that interference effects held regardless of whether or not target and distractor words belonged to the same grammatical class.

Siri et al. (2008) conducted a brain imaging study in which participants had to name pictures using a verb in the infinitive form (e.g., *to eat*), the same verb in an inflected form (e.g., *she/he eats*), or a noun (e.g., *the eating*). The authors failed to observe any verb-specific activation and concluded that, when all other factors are controlled, nouns and verbs are processed by a common neural system.

In light of these observations, it is not implausible that patients with a verb disorder may also be impaired in their ability to produce and/or comprehend nouns that express events. Collina, Marangolo, and Tabossi (2001) explored the effects of structural complexity on performance of patients with a putative verb selective impairment. They asked three Italian agrammatic patients who showed a noun/verb dissociation to produce nouns and verbs of different argument structure complexity. There were four sets of words: object nouns (e.g., *medaglia/medal*), event nouns (e.g., *pianto/crying*, *inseguimento/chase*), one-place argument verbs (e.g., *dormire/to sleep*), and two-place argument verbs (e.g., *distruggere/to destroy*). The task was to name pictures producing the different types of words. The performance of the three patients was almost identical. All made reliably fewer errors in the production of object nouns than in the production of verbs. Moreover, they made fewer errors with one-place than with two-place argument verbs and with object than with event nouns. Finally, in contrast with the previously observed noun/verb dissociation, no reliable difference was found between event nouns and verbs.

The present study

The present study explored whether impairment for event nouns similar to that observed by Collina et al. (2001) is shown by C.M., an agrammatic patient who during assessment showed a selective impairment in the production of verbs relative to object nouns. We hypothesized that a seemingly selective verb deficit may actually be accompanied by a deficit for event nouns. Moreover, the disruption of the two classes of words may indeed have a common origin³. To test this hypothesis, we conducted three experiments. In the first experiment, we explored the ability of C.M. to produce event nouns such as *destruction*, comparing her production of these words with object nouns and verbs. To anticipate the results, the patient had a reliably better ability in the production of object nouns than event nouns and verbs. However, as event nouns are morphologically complex words that are derived from verbs, it is conceivable that C.M.’s difficulties with these words have a morphological basis. We tested this hypothesis in Experiment 2. The results indicated that C.M.’s difficulties with event nouns are not entirely morphological. Therefore, we conducted a third experiment to investigate event nouns (e.g., *destruction*) and the verbs from which they derive (e.g., *to destroy*). We concentrated our attention on C.M.’s semantic and syntactic knowledge, testing whether her difficulties were due to a specific impairment in her knowledge of core meaning, thematic grid, or syntax of event nouns and verbs.

So far words such as *destruction* have received very little consideration in the production literature (Zwizserlood, 1994). Within current research, the mental lexicon is conceived of as a multilayer network of interconnected nodes, including at least three levels: a conceptual stratum, containing concepts; a lemma stratum, containing nodes with labelled links to syntactic nodes; and a form stratum, containing morpheme and segment

³ The study is not concerned with the possible differences between spoken and written language, and the claims concern the acoustic/phonological modality only.

nodes. Each word in the language, or more precisely each stem, has its own lemma node in the network, connected to one lexical concept. Activation, competition and selection processes take place in the network, and lexical access requires at least two distinct stages of processing: the selection of a lemma—that is, a semantically and syntactically specified lexical representation—and the selection of the corresponding phonological form, or lexeme (Dell, 1986; Levelt, Roelofs, & Meyer, 1999).

This general characterization holds also for the independent network model proposed by Caramazza (1997). The distinguishing property of this model is that word form selection does not necessarily require the prior retrieval of the word's syntax. Syntactic and form information are organized in sets of independent networks connected to each other by a modality-specific lexical node. The syntactic network is organized in sub-networks capturing different functions, such as category, gender, auxiliary type, and so on. To pronounce a word, the selected semantic representation sends activation to the syntactic and modality-specific networks. Under normal circumstances, activation from the semantic network is not sufficient to allow the retrieval of syntactic information. This requires the prior selection of the modality-specific node, which also activates the phonological properties of the to-be-pronounced word.

Although it is generally assumed that all derived lexical items have their own lemmas, each corresponding to one concept, whether represented in a distributed or localist fashion, in none of the current models is the production of morphologically complex words explained. Probably the most explicit in this respect is WEAVER ++ (Levelt et al., 1999). According to Levelt et al., derivational morphemes typically change a word's syntactic category. But syntactic category is a lemma level property; hence derived words must have their own lemmas, each corresponding to a distinct lexical concept (Levelt et al., 1999). In fact, items with bound derivational morphemes are considered single-lemma cases, and the intuitive relations that exist between words such as *destruction* and *to destroy* are captured

at the conceptual level where a word's meaning is connected through labelled links to related concepts (e.g., THE EVENT OF). In addition, there is a connection at the form level, where the words share constituent morphemes.

In a model of this sort (but the same holds for the independent network model), there is no obvious reason why words like *destruction* and *to destroy* should exhibit similar disruptions. They have different concepts and different lemmas. Moreover, syntactic and semantic properties of verbs, such as thematic grid and argument structure, are captured either in concept nodes or, at the lemma level, in verb nodes (e.g., V x, y) connected with the lemma of the lexical item. Thus, thematic and argument information associated with event nouns would be encoded separately from similar information associated with verbs, with no connections among them.

Evidence showing a common pattern of disruption for event nouns and verbs would call for a reconsideration of the assumption that these words are independently represented in the mental lexicon. In particular, it would provide a basis to re-examine whether event nouns and verbs really correspond to different concepts, or, as most linguists assume, they express in fact the same meaning (Giorgi & Longobardi, 1991; Grimshaw, 1990).

Case history

C.M. is a 71-year-old right-handed woman with five years of education. In January 2001, she suffered a stroke in the left hemisphere. The neurological examination revealed the presence of right hemiparesis and nonfluent aphasia. No other neurological problems were observed. A month later a computed tomography (CT) scan demonstrated a cortico-subcortical parietal lesion in the left hemisphere.

At the time of the investigation, 6 months after the stroke, her comprehension during conversation about familiar topics appeared good, but her spontaneous speech was reduced and agrammatic with omissions of verbs and function words and simplified syntactic structures. According to a

neuropsychological evaluation, she showed no oral, ideomotor, or ideational apraxia and scored 17 out of 36 (cut-off score: 18/36; Basso, Capitani, & Laiacona, 1987) on the Raven's Coloured Matrices test (Raven, 1965).

C.M.'s linguistic abilities were assessed using the Token Test—where she scored 14/36 (cut off score: 29/36; De Renzi & Faglioni, 1978)—and the BADA (Batteria per l'Analisi dei Deficit Afasici/Battery for the Analysis of Aphasic Deficits; Miceli, Laudanna, & Burani, 1994). Table 1 reports the number of correct responses on BADA language tasks.

C.M. was unimpaired in repetition, reading aloud, and writing to dictation of words and non-words, in sentence reading and repetition, and in word comprehension and was very mildly impaired

Table 1. Number of C.M.'s correct responses in the BADA's language tasks

Task	<i>N</i> correct responses
Nonword repetition	36/36
Nonword writing	25/25
Nonword reading	42/45
Lexical decision	
Auditory	76/80
Visual	77/80
Word/picture matching	
Auditory	40/40
Visual	40/40
Oral naming	
Nouns	26/30
Verbs	12/28
Written naming	
Nouns	12/22
Verbs	10/22
Word repetition	45/45
Word writing	42/46
Word reading	92/92
Sentence repetition	19/20
Sentence reading	6/6
Grammaticality judgements	
Auditory	36/48
Visual	17/24
Sentence/picture matching	
Auditory	41/60
Visual	33/45

Note: BADA = Batteria per l'Analisi dei Deficit Afasici/Battery for the Analysis of Aphasic Deficits.

in lexical decision tasks. On the oral naming task, C.M. showed dissociation between nouns and verbs with better preserved nouns than verbs: 4 errors in the production of 30 nouns and 16 errors in the production 28 verbs (13.33% vs. 57.14%), $\chi^2(1) = 6.32$, $p = .01$. Among the verbs, 16 were one-place and 12 two-place. C.M.'s performance with nouns (86.67%) was better than that with two-place verbs (18.75%), but not with one-place verbs (75.00%), $\chi^2(1) = 20.66$, $p < .0001$, and $\chi^2(1) = 0.84$, $p < .36$, respectively. In the written naming task she made 10 errors out of 22 trials with nouns and 14 errors out of 22 trials with verbs (45.45% vs. 63.64%), $p = .23$. Errors were mainly omissions in verb naming and semantic paraphasias in noun naming. She was severely impaired in grammaticality judgement and sentence comprehension.

In summary, C.M. had agrammatic speech, anomia more severe for verbs than nouns, and comprehension disorders. A sample of C.M.'s disordered speech is reported in Table 2.

Controls

In Experiment 1 only C.M. was tested. In Experiments 2 and 3 her performance was compared with that of 10 old healthy Italian speakers: 6 women and 4 men. They were matched with C.M. for age and education: mean age 71 years ($SD = 7.8$), mean years of education 6.4 ($SD = 2.6$). None of them had sustained any brain damage.

EXPERIMENT 1

The aim of this experiment was to establish C.M.'s ability to produce event nouns and to compare this with her ability to produce object nouns and verbs. The test devised by Collina et al. (2001) was employed. C.M. was first presented with a set of pictures depicting either object nouns (e.g., *angolo-angle*) or event nouns (e.g., *urlo/crying*) and was instructed to produce a noun corresponding to each drawing. After an interval, she was presented with another set of pictures representing

Table 2. Example of C.M.'s spontaneous speech

<i>Description of a day</i>	
<i>Italian</i>	<i>English</i>
<p><i>Sua giornata è vesti cioè oggi verso le otto, sette e mezza lava lavare . . . e poi dopo mangio e tira lì alla finestra aspetto. Aspetta l'obiettore di coscienza, Comune lì, Comune l'obiettore di coscienza, arrivare qui, arrivare loro tre, poi vai vai avanti recupero due un handicappato e un altro e poi arriva il Melo, arriva là il Melo. Poi salute cortesia veramente saluta tutti, come vai come va, e poi se come come so di . . . recupera, no, come se dise, i recuperi, come se dise, per esempio vieni qui con me, vieni qui con me, la fisioterapia, vieni qui con me, il film di là, come se dise, recu recuperare. Uno il fisioterapista, un altro il film, un altro parecchio, mangio, perché il tabello lì alle ore dieci tale, alle ore tale tale, recupera proprio. E poi dopo mangia verso la una mangia tutto il complesso e poi alle due TV e ormai sonno sonno e così tran tran.</i></p>	<p>Her day is (you) dress, I mean today around eight, seven and half (she) washes to wash . . . and then after (I) eat and pulls to the window and (I) wait. (S/he) waits for the volunteer, city council there, city council the volunteer, to arrive here, to arrive them three, then (you) go go on recovery two one handicapped and another and then (s/he) arrives the Melo (it is an house where the lady used to spend her days and that offers many different activities), arrives there the Melo. Then (s/he) says hello (instead of <i>saluto</i>, the Italian word for "I say hello", she said <i>salute</i>, which is not an existing inflected form of the verb <i>salutare</i>/say hell, and means <i>health</i>) courtesy she says hello to everybody, how are (you) how is (it), and then if how how (I) know to . . . recovers, no, how I can say (she used the dialect), the recovers, how to say that, for example come here with me, come here with me, the physiotherapy, come here with me, the movie there, how to say that, to reco recover. One the physiotherapist, another the movie, another (I) prepare the table (instead of <i>apparecchio</i>, the Italian word for "I set the table" she said <i>parecchio</i>, which is not an existing inflected form of the verb <i>apparecchiare</i>/set the table, and means <i>rather</i>), (I) eat, because the notice board (instead of <i>tabellone</i>, the Italian word for <i>notice board</i>, she said <i>tabello</i> that cannot be translated) there at ten (literally, "at the hours ten") such, at the hours such such, (s/he) really recovers. And then after (s/he) eats around one she eats the whole complex and then at two TV and by that time sleep (<i>noun</i>) sleep (<i>noun</i>) and thus on and on.</p>

Note: In the translation, subjects are in parentheses. They need not be expressed in Italian, and C.M. did not produce them. They have been added to make clear the verbal inflection the patient used.

events, and she was instructed to produce verbs (e.g., *nuotare*—to swim, *aprire*—to open).

If her difficulty is verb specific, she should find it harder to produce verbs than nouns, whether denoting objects or events. In contrast, if her impairment reflects difficulties typically associated with verbs but not necessarily restricted to this class of words, she might find the production of event nouns, like that of verbs, reliably more difficult than the production of object nouns.

Method

Materials

A total of 67 words reported by Collina et al. (2001) were used as targets. They consisted of 14

object nouns, 14 event nouns—10 one-place argument and 4 two-place argument—19 one-place argument verbs, and 20 two-place argument verbs (see Appendix A). The four sets of items were matched for syllable length, frequency, familiarity, concreteness, and imageability as shown in Table 3.

For each word, a picture representing its meaning was available (Collina et al., 2001). Examples are shown in Figure 1. The pictures were divided in two lists: A noun list included 28 pictures: 14 representing the object nouns and 14 representing event nouns; a verb list included 39 pictures, 19 representing one-place verbs and 20 representing two-place verbs.

Table 3. Mean values and standard deviations of the different groups of words employed in Experiment 1

Characteristic	Words			
	Nouns		Verbs	
	Object	Event	One-place	Two-place
Syllable number	2.64 (0.74)	2.43 (0.51)	3.16 (0.37)	3.5 (0.51)
Frequency	28.43 (24)	34.21 (29.14)	14.21 (29.59)	13.95 (14.72)
Familiarity	6.94 (0.06)	6.96 (0.10)	6.96 (0.09)	6.96 (0.07)
Concreteness	5.39 (0.94)	5.49 (1.01)	5.59 (0.98)	5.47 (0.73)
Imageability	5.49 (0.71)	5.32 (1.10)	5.76 (1.08)	5.37 (0.73)

Note: The first column refers to the characteristics considered. Standard deviations are in parentheses.

Procedure

C.M. was presented first with the noun pictures and after a 20-min interval with the verb pictures. Within lists, pictures were presented by the experimenter one at the time, in a random order and with no time limit. For the noun pictures, C.M. was instructed to produce a noun corresponding to what was depicted on each drawing; for the verb pictures it was made clear that she should name what was depicted in the picture using a verb. Prior to the presentation of each list, two examples were given. The patient had no problems in understanding the difference between nouns and verbs and followed the instructions without difficulty.

Results and discussion

The percentage of correct responses for the four types of words was calculated. Appropriate verb responses in any inflected form (e.g., *nuota-s/he swims*, *nuotare-to swim*, *sta nuotando-s/he is swimming*, *nuotava-s/he swam*) were considered correct. Likewise nouns, whether produced alone or accompanied by any determiner (e.g., *urlo/crying*, *l'urlo/the crying*, *un urlo/a crying*), were scored correct. Finally, unintended but appropriate responses and synonyms (e.g., *mangiare-to eat*, for *cenare-to dine*, *grido/crying for urlo/crying*) were also considered correct. C.M. never produced phonologically distorted realizations. All other responses were scored as an error. The results are summarized in Table 4.

C.M. produced more object nouns than verbs, although the difference was not significant, $\chi^2(1) = 2.14$, $p = .14$. She also produced more one- than two-place argument verbs and more verbs than event nouns, but again the differences were not statistically reliable, $\chi^2(1) = 3.30$, $p = .08$, and $\chi^2(1) = 3.16$, $p = .08$, respectively. She produced significantly more object than event nouns, $\chi^2(1) = 7.04$, $p = .01$. Finally, there was no difference between one-place and two-place event nouns (20% vs. 25%), $\chi^2(1) = 0.72$, $p = .40$.

C.M. had greater difficulty with verbs than object nouns, as observed during assessment, but the difference was reduced. This is likely to be due to the fact that, unlike in the BADA, in the present study nouns and verbs were matched for imagery values, with the result that object nouns were probably more difficult than in the assessment test, whereas verbs were of comparable difficulty: The percentage of correct object noun responses given by C.M. was 86.67% in the BADA and 71.43% in the present study, whereas the percentage of correct verb responses in the two tests was 42.86% and 48.76%, respectively.

C.M.'s performance was relatively good with one-place verbs, whereas production of two-place verbs was actually more impaired than that of object nouns, $\chi^2(1) = 4.37$, $p = .04$. This asymmetry was already present in the BADA. In fact, it is the difficulty of producing two-place verbs that gives rise to the noun/verb dissociation in C.M.

Several neuropsychological studies have shown that the number of obligatory arguments may

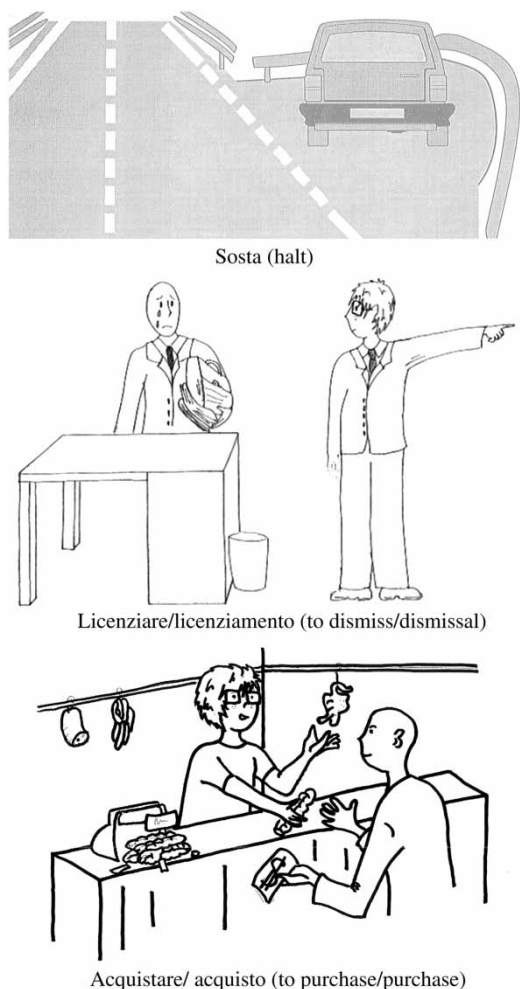


Figure 1. Three examples of pictures. *Sosta (halt)* was used in Experiment 1, *licenziare/licenziamento (to dismiss/dismissal)* and *acquistare/acquisto (to purchase/purchase)* were used in Experiments 2 and 3.

Table 4. Percentages of correct responses produced by C.M. in Experiment 1

	<i>N</i>	%
Nouns		
Object	14	71.43
Event	14	21.43
Verbs		
One-place	19	63.00
Two-place	20	35.00
Overall	39	48.76

affect the performance of agrammatic patients, and there is a hierarchy in verb production difficulty, which depends on the number and complexity of the verbs' argument structure (De Bleser & Kauschke, 2003; Kemmerer & Tranel, 2003; Kim & Thompson, 2000; Luzzatti et al., 2001; Thompson, 2003; Thompson et al., 1997). These findings have led to the so-called argument structure complexity hypothesis, according to which verbs with a more complex argument structure are more difficult to produce for people with agrammatism. Complexity refers to both the number of arguments and the type of argument structure. In particular, structures that trigger movement operations are more difficult than those that do not (Thompson, 2003). Consistent with this hypothesis, C.M. experiences greater difficulty with two- than with one-place verbs, showing that argument structure complexity is one aspect that renders her verb production difficult.

The novel finding is that C.M.'s production is more disrupted with event than with object nouns, and event noun production is in fact worse than verb production. This suggests that the patient's deficit is not limited to the verb category; rather it reflects difficulties in the production of words with complex semantic and/or syntactic representations.

Why is C.M. somewhat better with verbs than event nouns? Once again, the difference is due to her good performance with one-place verbs and disappears when event nouns are compared with two-place verbs ($p = .33$). Yet, if complexity affects both verbs and nouns, why do one- and two-place event nouns not show the asymmetry observed with verbs? Unfortunately, there were only 4 two-place nouns in this study. Therefore the comparison between these and one-place nouns is very weak, and no clear conclusions can be drawn on the basis of the present data. Possibly, with a larger number of items the difference between one- and two-argument structures would appear also with event nouns.

The findings indicate that even though the majority of event nouns were one-place, they were harder for C.M. than were verbs: $\chi^2(1) = 18.61$, $p < .0001$. One possible reason is their

greater morphological complexity. As already pointed out, in Italian almost all event nouns are morphologically derived from verbs. To minimize the possibility of morphological factors influencing C.M.'s performance, all the words in Experiment 1 contained only two morphemes, including the final inflectional morpheme, which is necessarily present in Italian content words (e.g., *lam-a/blade*; *buss-are/to knock*). However, even with these constraints, the event nouns used here, with a few exceptions, can be seen as derived from verbs with a zero suffix (e.g., *arrest-are/to arrest* → *arrest-o/arrest*). In this case they would still be morphologically more complex than object nouns and verbs, and derivational morphology is known to be impaired in some agrammatic individuals (Mathews & Obler, 1997; Mathews, Obler, Harris, & Bradley, 2001; Meth, Obler, Harris, & Swartz, 1995). During assessment, C.M. showed inflectional morphology impairments. However, inflectional and derivational morphology may be selectively disrupted in aphasic patients (Faroqi-Shah & Thompson, 2007; Miceli & Caramazza, 1988; Tyler & Cobb, 1987). Is derivational morphology impaired in C.M., and can this difficulty explain why event nouns are more difficult for C.M. than other word types?

We explored this possibility in Experiment 2. In particular, we tested whether C.M.'s deficit with event nouns is due to morphological complexity or whether, alternatively or in addition, there are nonmorphological reasons for her difficulties with these nouns. Morphological and structural factors are not incompatible, and there are different ways in which their effects could account for C.M.'s performance. One hypothesis is that structural complexity determines the difference between one- and two-place verbs, whereas morphological complexity determines the greater difficulty of event nouns than of all other words. Alternatively, structural complexity might affect C.M.'s production of both event nouns and verbs, and morphological complexity would add to this effect, rendering event nouns harder than other words, including verbs.

The latter interpretation has the advantage of offering a unified explanation of C.M.'s behaviour

with nouns and verbs. It makes two predictions. First, if the results of Experiment 1 reflect at least in part a genuine effect of the structural complexity of event nouns, C.M.'s behaviour should be more disrupted in the production of these words than in the production of nouns that have a comparable morphological complexity but do not have the semantic and syntactic properties that event nouns share with their corresponding verbs. Second, the nature of C.M.'s difficulties with nouns and verbs should have common origins. In this study we tested the first prediction, whereas the second prediction was tested in Experiment 3.

EXPERIMENT 2

Here, we compared the patient's performance with that of a control group of participants in the production of a new set of event nouns (e.g., *ferimento/wounding*), a set of object nouns matched with event nouns for morphological complexity (e.g., *sciatore/skier*), and the set of verbs from which the event nouns are derived (e.g., *ferire/to wound*). The task was picture naming. In the noun test, participants were requested to use a noun, whereas in the verb test they were requested to use a verb.

On the basis of the assessment tests and of the results of Experiment 1, we expected C.M.'s performance to be impaired compared to controls for event nouns and verbs. In addition, if the nature of her deficit with event nouns is morphological, C.M. should also be impaired in the production of object nouns, and her performance with these words and with event nouns should be similar. In contrast, if event nouns pose a specific problem, they should be harder than object nouns.

In the assessment tests, C.M. showed no peripheral auditory or articulatory difficulties. However, the words selected for this study were longer and more complex than those in the BADA and might have caused problems not detected in initial assessments. For this reason, prior to the word production test, we asked C.M. to perform a repetition test with the newly selected words. The test was not given to controls.

Method

Materials

Two sets of 13 event nouns were selected, such that for each noun in Set 1 there was another semantically related noun in Set 2. All the nouns were morphologically derived from a verb, with the exception of *furto/theft*, which is the event noun for *rubare/to steal*, but is not morphologically derived from it (Thornton, Iacobini, & Burani, 1997). On average, the 26 nouns were 2.69 ($SD = 0.47$) morphemes long. The mean frequency of their roots was 102.32 ($SD = 96$). The mean frequency of the derivational suffixes was 2,013 ($SD = 2,493$) out of 3,150,075 (Bertinetto et al., 2005). Their mean syllable length was 3.83 ($SD = 0.98$).

As mentioned in the introduction, with some event nouns the prepositional phrase headed by *di/of* is ambiguous, as it can express both the subject and the object of the corresponding verb. However, in the present study, we selected nouns that are unambiguous or become unambiguous when the *di*-phrase introduces an animate entity; 12 nouns introduced the subject and 14 nouns the object of the corresponding verbs. Following Cinque (1980), we refer to the former nouns as active and to the latter as obligatorily passive, or simply passive. Active and passive nouns were equally distributed in Sets 1 and 2.

In addition, 20 object nouns were chosen. They were complex nouns, morphologically derived from a variety of roots, and included different suffixes (Thornton et al., 1997). A total of 9 of these nouns had verbal roots, or suffixes typically expressing agents, or both (e.g., *sciare/to ski* → *sciatore/skier*, *bar* → *barista/barman*). Their mean length in morphemes was 2.65 ($SD = 0.49$). The mean frequency of the roots and the mean frequency of the derivational suffixes were 105.05 (96.16) and 2,771 (2,990) out of 3,150,075, respectively (Bertinetto et al., 2005). The 46 nouns were matched for the characteristics shown in Table 5.

Frequency was assessed using the *Corpus di Linguistica Computazionale* (1989) [Corpus of computational linguistics]. Three independent panels of 15 participants were each requested to

judge on a 7-point scale the familiarity (Connine, Mullenuix, Shernoff, & Yelen, 1990), concreteness, and imageability of all 46 words (Paivio, Yuille, & Madigan, 1968).

Finally, 26 verbs corresponding to the 26 event nouns were selected. Of these, 24 were two-place, and 2 were three-place argument verbs. As for nouns, three new panels of 15 Italian speakers assessed familiarity, concreteness, and imageability (see Table 5). The complete list of materials is reported in Appendix B. These words were used in the tests as follows.

Repetition test.

Nouns. A list including all the nouns was created. The list was divided into two blocks, each containing an equal number of event and object nouns.

Verbs. All the verbs were inserted in one list.

Word production test.

Nouns. One freehand-drawn picture was created for each of the selected nouns ($n = 46$). Two black-and-white pictures, one representing a character named Pippo and one representing a character named Mario, were also drawn. All the pictures representing events included both Pippo and Mario, with Pippo always performing the event.

To test the adequacy of the drawings, 20 Italian speakers were presented with the pictures and were requested to name them. The percentage correct was above 80% for all of the test pictures. Two lists were created, one containing event nouns ($n = 26$), and one containing object nouns ($n = 20$). Within lists, pictures occurred in a random order. Two examples of the pictures are given in Figure 1.

Verbs. The same 26 pictures as those used for event nouns were employed.

Procedure

Repetition test. C.M. was presented first the list of nouns and then the list of verbs. For nouns, she was told she would hear a list of nouns and should repeat each noun after hearing it, one at the time. After the practice trials, test nouns

Table 5. Mean values and standard deviations of the different groups of words employed in Experiment 2

	Words			
	Nouns			Verbs
	Object	Event		
		Set 1	Set 2	
Syllable number	3.65 (0.67)	4.08 (0.86)	3.85 (1.14)	3.77 (0.51)
Frequency	32.5 (40.26)	23.38 (21.92)	22.92 (29.64)	13.08 (14.95)
Familiarity	6.87 (0.17)	6.87 (0.15)	6.81 (0.8)	6.09 (1.42)
Concreteness	4.09 (1.47)	5.08 (1.30)	4.96 (1.01)	4.09 (1.47)
Imageability	5.43 (1.07)	4.57 (1.06)	4.16 (0.99)	4.39 (1.47)

Note: The first column refers to the characteristics considered. Standard deviations are in parentheses.

were read in a random order and at a comfortable listening level by the experimenter with no time restriction. A few days later the patient was given the verb list, using the same procedure, except that she was told she would hear and should repeat verbs.

Word production test.

Nouns. Event and object pictures were presented separately, one week apart. Event nouns were tested first. Initially participants were shown the pictures of Pippo and Mario and were told that they would see Pippo performing different events. Their task was to name what he did using one noun only. Throughout the test, Pippo's picture remained available to the participants. For object nouns, participants were instructed to name the depicted item. After receiving instructions and one example, participants were presented with the pictures one at a time without time limit. If the response was not the target, a second answer was encouraged and, if correct, was accepted.

Verbs. The procedure was the same, except that participants were instructed to produce a verb.

Results and discussion

Repetition test

C.M. was flawless with object nouns, event nouns, and verbs alike. Therefore, her impairments with

these words are not due to auditory or articulatory difficulties.

Word production test

Nouns, produced alone or with any modifier, were considered correct. Verbs, produced alone in any morphological form or in any combination with other words (e.g., *Pippo arrests; Mario arrests; he arrested*) were considered correct. Any other response was scored as an error. Results of the production test are reported in Figure 2.

Nouns. C.M.'s performance with object nouns was worse than that of controls (35.00% vs. 99.00%), $t(9) = -29.06$, $p < .001$, as was that with event nouns (7.69% vs. 95.94%), $t(9) = -15.22$; $p < .001$). In addition, unlike controls, C.M. produced significantly fewer correct event than object nouns (7.69% vs. 35.00%), $\chi^2(1) = 5.36$, $p = .02$. Of the 37 errors made by C.M., 17 were semantic (e.g., *combattimento/fight* → *box/boxing*), 7 were unrelated nouns (e.g., *ammirazione/admiration* → *relax/relaxing*), 5 were omissions, 4 were morphological errors (*fulcrazione/shooting* → *fulcila/(he) shoots*), and 4 were circumlocutions (e.g., *acquisto/purchase* → *dare e prendere . . . non so/to give and to take . . . I don't know*).

Verbs. C.M. produced fewer correct responses than controls (34.48% vs. 94.23%), $t(9) = 6.21$, $p < .001$. Of the 16 errors she made, 8 were circumlocutions (e.g., *combattere/to fight* → *pugno in faccia a*

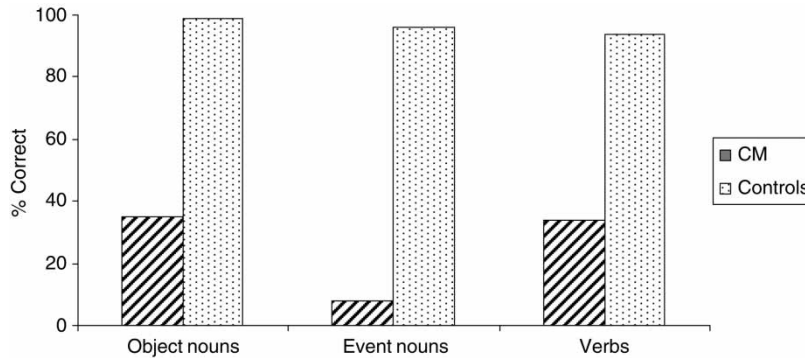


Figure 2. Results of the word production test in Experiment 2.

Mario/fist on Mario's face), 5 were semantic substitutions (e.g., *arrestare/to arrest* → *catturare/to capture*), and 3 were verbs unrelated to the target (e.g., *assumere/to employ* → *parla/he speaks*). When producing errors, the patient signalled that her responses were not correct, and her productions were only approximations to targets, suggesting better knowledge of core meanings of verbs than she could express. C.M.'s performance with object nouns and verbs was very similar (35.00% vs. 34.48%), *ns*. In contrast, the patient produced reliably fewer correct event nouns than verbs (7.69% vs. 34.48%), $\chi^2(1) = 6.93, p = .008$.

At least in oral production C.M.'s performance is disrupted with derived words. This deficit is likely to explain why the noun/verb dissociation observed in assessment disappears when verb production is compared with the production of derived object nouns: While argument complexity affects verb production, derivational complexity affects object noun production, rendering C.M.'s performance with the two types of words very similar.

However, among morphologically derived nouns, event nouns are harder for the patient than are object nouns. The two groups of words were matched as much as possible. For example, event nouns differed from one another as some are more lexicalized than others (e.g., *acquisto/purchase* vs. *carcerazione/jailing*); similarly, object nouns varied along this dimension (e.g., *biancheria/linen* vs. *sciatore/skier*). Likewise, phonological transparency varied across event (e.g., *ferire/*

to wound → *ferimento/wounding* vs. *stringere/to grip* → *stretta/grip*) as well as object nouns (e.g., *dente/tooth* → *dentista/dentist* vs. *tempo/weather* → *temporale/thunderstorm*). Thus, C.M.'s worse performance with event than object nouns suggest that, over and above the morphological deficit, nouns denoting events pose a special problem to C.M.

Evidence in the literature indicates that the production of complex words may be sensitive to the syntactic characteristics of the constituents. For example, Mondini, Luzzatti, Semenza, and Calza (1997) describe an Italian agrammatic patient—M.B.—who in a number of different tasks showed a severe deficit in the use of prepositions. Consistent with this impairment, in the picture-naming task where the target words were prepositional compounds his most frequent error was the omission of the preposition (e.g., *mulino a vento/windmill* → *mulino vento*). Similarly, a group of Italian Broca aphasics, who showed a greater difficulty producing verbs than nouns tended to omit the verbal rather than the nominal part of V + N (verb + noun) compound words (e.g., *spazzacamino/chimney sweeper* → *camino/chimney*; Semenza, Luzzatti, & Carabelli, 1997). Therefore one might wonder whether the present findings reflect the patient's difficulty at producing event nouns or more generally words that have verbal or agentive components. But in this study half of the object nouns had a verbal or agentive component (or both), and half had not, and C.M.'s correct responses were evenly

distributed across the two types of noun (3 and 4, $p = .64$), which equally contributed to the advantage of object over event nouns.

These findings rule out the hypothesis that morphological complexity accounts completely for C.M.'s deficit with event nouns. Rather, morphological and structural complexities both affect the patient's production. In fact, if one considers C.M.'s performance with all the various types of words considered so far in Experiments 1 and 2 (Table 6), it is apparent that morphological complexity shows up with object nouns, structural complexity shows up with verbs, and both appear jointly in the production of event nouns, which is therefore more disrupted than the production of the other words.

But what is the nature of the problems that C.M. experiences with event nouns and verbs? Are these problems the same for the two classes of words? Experiment 3 aimed at clarifying these issues.

EXPERIMENT 3

In this study, we explored C.M.'s ability to use different types of semantic and syntactic information during event word comprehension or production. To this end, we devised several tests in which we compared her performance with that of controls. In particular we tested three aspects of C.M.'s comprehension. Since a plausible cause of C.M.'s deficit with event words is a disruption of core semantic representations, we performed a core comprehension test, where we

Table 6. Percentages of C.M.'s correct responses in the production task for the different types of words in Experiments 1 and 2

Words	Experiment	%
Object nouns		
Morphologically simple	1	71.43
Morphologically complex	2	35.00
Event nouns		
Morphologically complex	2	7.69
Verbs		
One-argument	1	63.00
Two-argument	1	35.00

investigated the patient's comprehension of object nouns, event nouns, and verbs. Moreover, since thematic information is an important part of the semantics of event nouns and verbs, we conducted a thematic role test to evaluate C.M.'s comprehension of this aspect. Finally, it is well known that an important piece of information that must be available to speakers/listeners when they use a verb or an event noun is how constituent arguments are realized (Schwartz et al., 1980). As mentioned in the introduction, most linguists assume that there is a systematic mapping between components of verb meaning—such as thematic roles—and the syntactic realization of the arguments (Levin & Rappaport Hovav, 2005). However, some evidence suggests that a verb's syntax may be somewhat independent from its semantics. For example, in spite of the semantic similarity of *to rid* and *to empty*, the former requires an indirect complement (e.g., **Bill rid the room of insects* but *Bill rid the room*), whereas the latter may or may not (e.g., *Bill emptied the room of insects* and *Bill emptied the room*; Jackendoff, 1990). Independence between these two components is also suggested by neuropsychological and neuroimaging data (Breedin & Martin, 1996; Caramazza & Miceli, 1991; Martin & Blossom-Stach, 1986; Shetreet, Palti, Friedmann, & Hadar, 2007). For these reasons, we tested C.M.'s ability to use subcategorization information during comprehension.

The selection of the appropriate task to explore this ability is not straightforward. In particular, some agrammatic patients with asyntactic comprehension have been reported to possess intact judgement abilities (Caplan & Hildebrandt, 1988; Linebarger, 1990; Schwartz, Linebarger, Saffran, & Pate, 1987). However, agrammatic patients' syntactic comprehension has often been tested successfully by means of the grammaticality judgement task (Breedin & Martin, 1996; Grodzinsky & Finkel, 1998; Kim & Thompson, 2000). In fact, Breedin and Martin (1996) used grammaticality judgements to examine precisely the same ability as that we explored here. Hence, consistent with what has been done in prior research, we decided to employ the grammaticality judgement task.

With respect to production, we conducted a role production test, aiming at assessing C.M.'s ability to use thematic information in production. Ideally, we would have completed the set of tests exploring C.M.'s ability to produce appropriate syntactic frames for event nouns and verbs. However, the production of a syntactic frame for event nouns requires the production of a preposition (e.g., *the fight with the man*), whereas the appropriate syntactic frame for a verb requires the production of the verb (e.g., *Peter chases Mary*), and we know that C.M. is severely impaired in the production of these classes of lexical items. Therefore, in the likely case in which she should fail to produce the appropriate frames, it would be impossible to distinguish between a lexical and a syntactic deficit. For these reasons we did not test C.M.'s syntactic abilities in production.

In the assessment tests, C.M. had good comprehension of words, but showed syntactic deficits both in comprehension and in production. Therefore, we expected her performance in the core comprehension test to be within a normal range or only marginally impaired. In contrast, we expected her performance in the grammaticality judgement test to be damaged. The assessment tests did not give us any information concerning the patient's ability to use thematic role information, for which we had no predictions.

Method

Materials

Core comprehension test.

Nouns. The pictures devised for Experiment 2 were used to create two separate sets. The event set included 26 triplets of pictures, whereas the object set contained 20 triplets. A triplet consisted of two pictures representing semantically related nouns and one picture representing an unrelated noun (e.g., *fucilazione/shooting; impiccagione/hanging; abbraccio/embrace*). Each picture occurred in three triplets: once as a target, once as a related distractor, and once as an unrelated control. The two sets were used to create one event list and one object list, where each triplet was paired with a target noun. Within lists the order of the trials

varied randomly with the restriction that the same picture could not appear in two subsequent trials.

Verbs. The pictures were the same as those in the event list, but the words paired with them were verbs rather than nouns.

Role comprehension test.

Nouns. A total of 52 drawings representing event nouns were used: 26 pictures, where Pippo was the performer, were the same as those used in the production task. The remaining 26 pictures were new: They were identical to the former, with the exception that the performer was Mario. For each noun two NPs of the form "the N of X" were created, where N was the event noun, and X was Pippo in one expression and Mario in the other. Each expression was paired with the two pictures representing the event: One was the target, and the other had the roles of the characters exchanged. Overall, a list of 52 trials was created. Pippo and Mario appeared an equal number of times in the target pictures and occurred equally often as agent and theme.

Verbs. Pictures were the same as those for nouns. However, nominal expressions were replaced by short sentences of the form "NP V NP".

Grammaticality judgement test.

Nouns. For each of the 26 event nouns, 2 noun phrases were created, 1 syntactically correct and 1 incorrect. The 26 syntactically correct NPs consisted of an event noun preceded by the appropriate determiner and followed by a prepositional phrase appropriately expressing either the agent or the theme of the event; the 26 incorrect NPs were derived from the former, but the preposition was substituted by an incorrect one. The number of arguments was not manipulated and was always appropriate (e.g., *L'ammirazione per Maria/The admiration for Mary; *L'ammirazione su Maria/*The admiration on Mary*). Two sets of 26 trials each were devised. Each set contained the same number of acceptable and unacceptable phrases.

Verbs. A subset of 20 verbs was used for the grammaticality judgement task. For each verb two sentences were created, one syntactically correct and one incorrect. The syntactically correct sentences had one of the following structures: NP–V–NP, NP–V–PP, or NP–V–NP–PP. The incorrect sentences had the same structures, but contained inappropriate complements. As for nouns, the number of arguments was not manipulated and was always appropriate (e.g., *Il pubblico ammira la cantante lirica*/*The audience admires the lyric singer*; **Il pubblico ammira per la cantante lirica*/**The audience admires for the lyric singer*). Two sets of 20 trials each were constructed. Each set contained the same number of acceptable and unacceptable sentences.

Role production test.

Nouns. The same pictures as those in the role comprehension test were used. Two sets of 26 trials each were created. Each set contained the same number of trials where the correct responses required the production of the agent and of the theme. Moreover, Pippo and Mario occurred the same number of times in the two roles.

Verbs. The same sets of drawings as those for the nouns were used.

Procedure

The tests were presented in the order reported in the text, first for nouns and then for verbs.

C.M. performed the tests in about five hours. Controls performed the tests in about three hours.

Core comprehension test.

Nouns. The event list and the object list were given separately, one after the other in a single session. Within each list trials were presented in a random order. On each trial, the experimenter read aloud the target noun and then presented the paired triplet in front of the participants. One picture represented the meaning of the target noun, one represented a semantically related noun, and one was an unrelated control. Before presentation of the event list, participants were shown the picture of Pippo and were told

that they would see pictures of him performing different events. Their task would be to select from among three pictures the one representing the event named by the experimenter. Before the object list, participants were simply requested to select the picture corresponding to the word pronounced by the experimenter. In both cases, an example was given prior to the test proper. Participants had as much time as they wished to point to the correct picture.

Verbs. The procedure was the same as that for the nouns. Here, however, only the pictures representing events were presented, and instead of the event nouns, the experimenter read out loud the corresponding verbs in the infinitive form.

Role comprehension test.

Nouns. On each trial, the experimenter read aloud expressions like “*L’ammirazione di Pippo*”/“*The admiration of Pippo*”, while presenting two pictures. One picture represented the event described by the expression, and the other was identical, expect that the roles of Pippo and Mario were exchanged. The task was to point to the picture correctly representing the meaning of the expression read by the experimenter. One example was provided prior to the experiment. The target appeared an equal number of times on the right and on the left of the picture array. Trials were presented in a random order with the restriction that the same event noun did not appear twice consecutively. For the patient, trials were divided in two sets of 26 trials each, with a one-hour break between the two, while the controls performed the task without any break.

Verbs. The test was the same with verbs, but instead of a NP, the experimenter read out loud a sentence (e.g., *Mario ammira Pippo*/*Mario admires Pippo*).

Grammaticality judgement test.

Nouns. Participants were seated in front of the experimenter who read each expression successively. Their task was to decide whether or not the phrase was an acceptable Italian expression.

Two examples were given. The order of presentation of the two noun sets was counterbalanced across the control participants. Within each set, the phrases were presented in a random order, with the restriction that the same event noun would not appear in two consecutive trials.

Verbs. The procedure was the same as that for the nouns, but the experimenter read a sentence. Trials were presented to the patient with a one-hour break between each set. Control participants performed the trials without a break.

Role production test.

Nouns. On each trial the experimenter read aloud an event noun preceded by the appropriate determiner (e.g., *l'inseguimento/the chase*) while showing the participant a picture. The participant's task was to describe correctly the picture completing the noun phrase and producing the appropriate *di*-phrase (e.g., *of Mario*). In half of the cases this expressed the agent, and in half the theme of the event. One example was provided.

Within each set, picture presentation was in a random order with the restriction that the same event noun was never presented in two consecutive trials. C.M. was presented with the two sets with a one-hour interval between presentations. Control participants performed the task without any break. The order of presentation of the sets was counterbalanced across control participants.

Verbs. The experimenter first read aloud a verb in the present tense, third person singular while showing the participant a picture, and then asked "Who did it?" The task was to produce the name of the correct character—namely, the agent. Assessing the ability to assign themes would have required asking rather difficult questions, often using the passive form. Moreover, we were unable to find a single question that would appropriately apply to all the verbs. For these reasons, we tested only agent assignment with verbs.

Results and discussion

For expository purposes, the results for nouns and verbs in the different tasks are reported together. They are summarized in Figure 3.

Core comprehension test

The selection of the correct picture was considered a correct response. Everything else was scored as an error.

Nouns. C.M., like controls, was 100% correct with the object nouns. Her performance with event nouns was below normal (76.92% vs. 97.60%), $t(9) = 5.11$, $p < .001$. The six errors she made were all semantic confusions.

Verbs. C.M.'s comprehension of verbs was below controls' performance (84.62% vs. 94.41%), $t(9) = 6.38$, $p < .001$. Her four errors were all semantic.

There was no evidence that C.M.'s comprehension of event nouns and verbs differed (76.92% vs. 84.62%), $\chi^2(1) = 2.08$, $p = .15$.

Role comprehension test

Pointing to the appropriate picture was scored as a correct response.

Nouns. C.M. needed an additional example before the test. To this end, the trial containing "*il ferimento di Mario*"/"*the wounding of Mario*" was employed and was subsequently excluded from the analyses. Overall, C.M.'s percentage of correct responses (72.54%) was better than chance, $p = .04$, but lower than controls (97.40%): $t(9) = 8.20$, $p < .001$. Her comprehension was poorer than controls for agents (83.33% vs. 100%), $t(9) = 15.26$, $p < .001$, and themes (55.56% vs. 96.95%), $t(9) = 9.92$, $p < .001$. However, C.M.'s performance was better with agents than with themes, $\chi^2(1) = 4.55$, $p = .03$, whose comprehension was not above chance (55.56%), $p = .50$.

Verbs. The patient's comprehension of the roles assigned by verbs was damaged (72.55% vs.

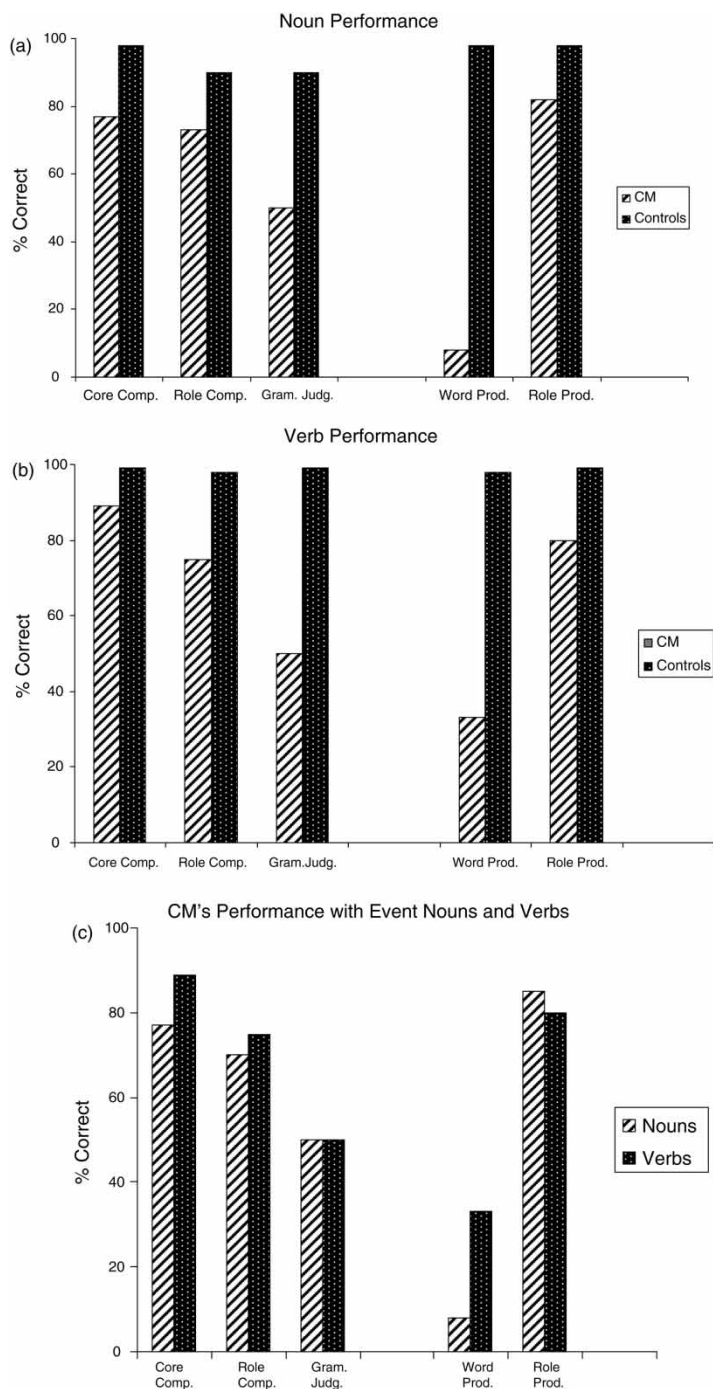


Figure 3. Figure 3a shows the percentage of correct responses produced by C.M. and by the controls in the different tasks performed in Experiment 3 and in the production task in Experiment 2 for event nouns. The results of Figure 3b show the corresponding percentages for verbs. Figure 3c shows the percentage of correct responses produced by C.M. for event nouns and verbs.

98.08%), $t(9) = 12.61$, $p < .001$. It was impossible to maintain the agent/theme distinction with verbs, for which correct sentences, unlike NPs, must express both roles.

C.M.'s performance in role comprehension is identical for nouns and verbs (72.54% vs. 72.55%) and in both cases is pathological.

Grammaticality judgement test

Nouns. C.M.'s performance was reliably worse than that of controls (48.08% vs. 92.27%), $t(9) = 3.83$, $p < .002$. The patient showed a strong bias to judge all the expressions as correct. In fact, her percentage of correct acceptances was significantly different from her percentages of correct rejections (80.77% vs. 15.38%), $\chi^2(1) = 22.26$, $p = .001$. C.M.'s performance in this task was reliably worse than that in role comprehension (48.08% vs. 72.54%), $\chi^2(1) = 13.08$, $p = .0003$.

Verbs. Only about half of the responses given by C.M. were correct (47.50% vs. 99.00%), $t(9) = 49.10$, $p < .001$. As with nouns, her acceptance rate was reliably higher than her rejection rate (90.00% vs. 15.00%), $\chi^2(1) = 14.30$; $p = .001$.

Again, as with nouns, the patient's ability in this task was reliably worse than her ability to comprehend roles (47.50% vs. 72.55%), $\chi^2(1) = 13.08$, $p = .003$. There was no reliable difference in C.M.'s performance with nouns and verbs (48.08% vs. 47.50%).

Role production test

Responses where the participant produced the appropriate name were considered correct. Everything else was considered an error.

Nouns. There was a reliable difference in role production between C.M. and controls (84.61% vs. 97.90%), $t(9) = 3.75$, $p < .002$. She showed some difficulties with themes (78.57%, $N = 28$), but these difficulties did not approach a reliable level when compared with C.M.'s agent assignment (91.67%, $N = 24$), $p = .19$, or when compared with controls' performance (96.79%), $t(9) = 0.039$, $p = .97$.

Verbs. C.M.'s performance in assigning agents to verbs was different from that of controls (82.14% vs. 99.40%), $t(9) = 17.14$, $p < .001$.

There was no evidence that the patient's performance differed with nouns and verbs (84.61% vs. 82.14%), $\chi^2(1) = 0.33$, $p = .57$.

Comprehension tests indicate that C.M.'s knowledge of core meanings is not completely spared, but is still rather good. Also, she has difficulties with thematic assignment, and this difficulty is more severe with themes than with agents. On the whole, C.M. shows semantic problems in comprehension, but these problems are not nearly as severe as her difficulties performing grammaticality judgements. C.M. cannot distinguish between syntactically acceptable and unacceptable expressions, either noun phrases or sentences. Overall, her performance in this task is worse than one would expect based on the results of the role comprehension task. In particular with event nouns, she is not better with NPs expressing agents than with those expressing themes. While her performance with passive nouns might derive from her inability to comprehend themes, the inability to judge the correctness of NPs expressing agents cannot entirely derive from her role impairment.

The role production test indicated that C.M.'s production of roles is not spared, even though her overall performance is good, both with nouns and with verbs.

Taken together, the findings indicate that C.M.'s deficit is not selective, as all the aspects of semantic and syntactic information tested here appear to be impaired. However, there are obvious differences across tasks. In all the tasks involving semantic information her performance is only mildly impaired, and approximately 80% of her responses are correct. In contrast, in the only syntactic task we were able to conduct (grammaticality judgement) she behaved at chance level.

C.M. had an almost identical performance with nouns and verbs. This corroborates the hypothesis that her deficits with the two classes of words have common origins. We discuss the implications of these results in the next section.

GENERAL DISCUSSION

C.M. is an agrammatic patient who showed a greater impairment in the production of verbs than of nouns. However, she had no problems in distinguishing between the two classes of words and showed no difficulties following instructions. Experiment 1 revealed that her production is reliably worse with event nouns than with object nouns. The syntactic category dissociation observed in assessment disappears when verbs are compared with event nouns. Moreover, C.M. is reliably worse with two-argument than with one-argument verbs, indicating that argument complexity affects her ability to produce these words.

As event nouns are almost always verb nominalizations, a morphologically based explanation of their difficulty, particularly in an agrammatic patient, is highly probable. However, Experiment 2 indicated that, although C.M.'s production is affected by morphological complexity, this impairment does not account entirely for her difficulty with event nouns.

Experiment 3 showed that C.M. does not have a selective impairment, as none of the tested aspects are completely spared. However, at least in comprehension the use of subcategorization frames appears most severely impaired. The pattern is almost identical for event nouns and verbs.

One difficulty with studies like the present one is that it is practically impossible to match pictures for visual complexity, as object pictures are inevitably simpler than event pictures. Also, one-argument verbs like *to cry* can be depicted with just one person crying, but two-argument verbs like *to lick* require someone licking something. In principle, these visual differences might explain C.M.'s better performance with object nouns than with event nouns and verbs, and with one- than two-argument verbs. However, one of the BADA tasks performed by C.M. during assessment was a word/picture matching task. In that task, half of the words are nouns, and half are verbs—some one-place, and some two-place. As in the present study, in the BADA word/picture matching task

verb pictures are more complex than noun pictures, and two-place verb pictures are more complex than one-place verb. In spite of these differences, C.M.'s performance was flawless (see Table 1), suggesting that she was able to analyse appropriately complex as well as simple images, and visual complexity was not a problem for her. Given that result, we decided that it was not necessary to check experimental materials for visual complexity, and it is most unlikely that the present findings can be accounted for on that basis.

The fact that C.M.'s production is worse with event than object nouns and no better with event nouns than with verbs calls into question the grammatical class interpretation of the impairment that C.M. showed in assessment with verbs. More generally, it casts doubts on the notion that grammatical class always explains the N/V double dissociation often described in the neuropsychological literature.

One of the appeals of this hypothesis is that it provides a unified interpretation for noun and verb deficits. Moreover, the claim that grammatical class is an important organization principle in the lexicon is justified on independent grounds. At least for nouns and verbs, for example, the distinction seems universally present to some extent in all languages (Sapir, 1921). Evidence from event-related brain potential (ERP) studies suggests that a syntactic category violation produces very early, specific brain responses. For example, Friederici, Hahne, and Mecklinger (1996) found that an unambiguous noun/verb violation during sentence auditory comprehension elicited a left anterior negativity as early as 370 ms after word onset (50 ms after the word category uniqueness point). Imaging research has produced less clear-cut results (Perani et al., 1999; Thompson et al., 2007; Tyler, Bright, Fletcher, & Stamatakis, 2004; Tyler, Russell, Fadili, & Moss, 2001). However, some findings (Shapiro, Moo, & Caramazza, 2006) strongly corroborate the view that noun processing is supported mostly by the temporal lobes, whereas verb processing is supported mostly by the frontal and parietal lobes (Damasio & Tranel, 1993).

The present data do not argue against the relevance of the noun/verb distinction and have no implications for the interpretation of noun deficits, which may well be class-specific. Also, they are not inconsistent with the claim that semantic and grammatical dimensions both contribute to the organization of the mental lexicon (Laiacina & Caramazza, 2004). However, they suggest that the grammatical class-specific interpretation of some verb production deficits reported in the literature may actually be wrong. When the verb deficit results from damage to aspects of knowledge shared by other words, these words may also be impaired, regardless of grammatical class.

Although C.M.'s performance is pathological in various ways, the ability most severely disrupted at least in comprehension is the use of syntactic information, both with event nouns and with verbs. As already pointed out, most linguists assume that a verb's argument realizations are largely determined by semantic characteristics such as its thematic grid. In the constructionist approach, the verb's participant roles must be compatible with the argument roles, which constitute the semantic component of the construction itself. In both cases, thematic and syntactic information are tightly connected, and the disruption of syntactic frame information should either derive from the disruption of thematic information or parallel it. Since the structures posited in this approach convey meaning, they should be shared by the comprehension and the production system. However, in comprehension, where we were able to test C.M.'s ability in tasks involving both thematic and syntactic information, she had a reliable better performance in the former than in the latter. The statistical analyses supporting these differences call for great caution, as they result from obviously different tasks. However, insofar as the tasks tap into C.M.'s thematic and syntactic comprehension, an explanation of the patient's syntactic deficit entirely based on or parallel to her semantic impairment seems very unlikely.

The present results are in agreement with those reported in several other studies (Breedin & Martin, 1996; Caramazza & Miceli, 1991; Martin & Blossom-Stach, 1986; Shetreet et al.,

2007). In Martin and Blossom-Stach, for example, patient W.S. had a thematic role deficit, but had preserved subcategorization information. Also, in a functional magnetic resonance imaging (fMRI) study, Shetreet et al. found patterns of activation consistent with the notion that "the representation of subcategorization is separate from the representation of thematic frames" (Shetreet et al., 2007, p. 1966). This evidence suggests there may be a higher degree of independence in the representation and access of thematic and subcategorization information than is often assumed in linguistics (but see Grimshaw, 1979).

How do current models of word production account for C.M.'s performance? In particular, how do they explain her greater disruption with event than with object nouns of matched morphological complexity and the almost identical performance with event nouns and verbs? As mentioned in the introduction, within a framework such as WEAVER ++ (Levelt et al., 1999) there is no reason why event nouns should behave like verbs. Also, while C.M.'s difficulties at producing complex words is easily explained with the loss or inability to access morphological representations at the lexeme level, it is not clear why event nouns should be more difficult than other complex nouns. A possible solution would be to posit that thematic grids are specified at the semantic level in independent nodes that are connected with and shared by the concepts that have those grids. Damage to thematic nodes would result in impairment at producing the words whose concepts are linked to those nodes—that is, verbs and event nouns. Moreover, since event nouns are morphologically complex, the morphological and the thematic problem accumulate in these words, which accordingly are the hardest words for C.M.

Although we do not have direct evidence of C.M.'s ability to use lexical syntactic information in production, we know that she has a much better ability in role production than in event word production, suggesting that the thematic role impairment is unlikely to be completely responsible for C.M.'s very poor event word

production. Within WEAVER + +, this asymmetry can be accounted for assuming that, alternatively or in addition to thematic knowledge impairment, C.M. has a damage to subcategorization knowledge, and this information is specified in syntactic nodes independent from lexical category information. If both the lemma of a verb and that of the corresponding event noun are linked to the same subcategorization information nodes, damage or difficulties at accessing these nodes would result in a deficit at producing both types of words.

One difficulty with this account is that, unlike thematic grids, subcategorization frames for event nouns and verbs are different. However, since the former can be derived from the latter, the problem might perhaps be solved assuming that event nouns are connected with the same subcategorization nodes as those for the corresponding verbs, from which the appropriate syntactic frames are derived by rule. In this way, difficulties related to subcategorization information account for C.M.'s poor production of event nouns and words, whereas morphological disruption accounts for her difficulties with complex words. As before, the two problems sum up in event nouns.

As in WEAVER + +, in the independent network model (Caramazza, 1997) morphemes are represented at the lexeme level. Therefore a disruption at this level or damage in the connections sending activation from the concepts to the corresponding morphemes can account for C.M.'s impairment with derivational morphology. However, it is unclear why event nouns are harder to produce for C.M. than morphologically matched object nouns, since many of them had verbal roots.

In this model, the similarity between event nouns and verbs may result from the fact that the concepts associated with a verb and with the corresponding event noun send activation to the same root at the lexeme level. Thus, any damage concerning this root could produce similar effects on the words sharing it. In addition, one distinguishing characteristic of the independent network is that lexemes activate syntactic information. Therefore, if they are damaged, syntactic

information will also be poorly activated. C.M.'s possible disruption of subcategorization information would be consistent with this hypothesis. However, class category information is perfectly intact in our patient, and it is unclear why difficulties concerning a root should produce impairments in the use of subcategorization information, leaving class category information unimpaired.

What these alternative explanations have in common is that all derived lexical items are assumed to have their own lemmas, each corresponding to one concept. There are good reasons for this choice. One concern, for example, is that, unlike inflectional morphology, derivational morphology alters the meanings of the derived words in ways that may or may not be transparently derived from the component parts. Thus, the meaning of *buyer* can easily be derived from the meanings of *to buy* and *-er*; but the same mechanisms would lead to an incorrect interpretation of a word like *cooker*.

However, event nouns seem to differ somewhat from other derived words. A nominalization is a noun in a NP that expresses the content of a sentence. For example, *ammiratore/admirer* is a nominalization centred on the NP, precisely the subject of a sentence containing the corresponding verb (e.g., *Ho incontrato la persona che ammira Maria/I met the person who admires Mary*), whereas *invenzione/invention* expresses the direct object of a sentence (e.g., *Ciò che ha inventato Marconi è famoso/What Marconi invented is famous*). The meaning and syntax of these words differ from those of the corresponding verbs.

In contrast, event nouns (in their nonresult interpretation) have the same core meaning and thematic grid as do the corresponding verbs. In particular the meaning of verb-centred nominalizations is typically derivable from the verb and can be paraphrased as "the fact + verb" or "the event of + verb", depending on the kind of verb considered. Also, the result interpretation that is usually associated with an event noun but not with the corresponding verb (e.g., *The arrival is one kilometre away*) does not necessarily indicate the existence of two distinct concepts. Rather it may be the outcome of the properties, semantic

as well as syntactic, that percolate to the derived word from its nominal suffix (Scalise, 1994).

These considerations led us to hypothesize that C.M.'s performance with event nouns would be similar to her performance with verbs. The findings corroborated the hypothesis, suggesting a homogeneous explanation of the noun and verb deficit. A simple account is to assume that the mental lexicon captures a large amount of semantic and syntactic information, and event nouns and corresponding verbs share much of this information along the lines proposed by Schreuder and Baayen (1995) in a model of morphological processing during comprehension. In this model, a word such as *ruimte/spaciousness*, formed by the adjective *ruim/spacious* and the suffix *-te/th* (as in *warmth*), has a lexical representation—a concept node in Schreuder and Baayen's terminology—which is connected with syntactic and semantic representations. Both these types of information (e.g., the semantic information "space") may be shared by different lexical representations.

In a production perspective, the concept of a verb may be connected not only to its lemma, but also to the lemma of the corresponding event noun, which, in addition, is linked to the semantic representation of the suffix. Equally shared is the thematic and argument structure information, whereas the noun's subcategorization frames might be generated from the verb as a consequence of its combination with the nominal suffix. In this framework, damage to verb semantic or syntactic information or access difficulty results in a comparable deficit to that for the corresponding event noun.

C.M. has a disproportionate difficulty when producing verbs. This impairment does not result from the selective deficit to one component of the production mechanism, as all the aspects we tested appear to be compromised. But whatever is the impairment with verbs, she suffers similar disruption with event nouns. Moreover, since C.M. has a serious morphological deficit, her difficulty at producing event nouns is made more severe by the greater morphological complexity of these words.

The proposed explanation is coherent with neuropsychological evidence suggesting that during normal processing the lexical production

system can use compositional mechanisms not only at the formal level, but also at the semantic/syntactic level (Allen & Badecker, 2000). However, we know very little of how exactly different types of words may be represented and processed. The present study is perhaps an initial step towards this goal, suggesting that the mental representation and processing of verb-centred nominalizations may actually be very similar to those of verbs.

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APPENDIX A

List of the Italian words (and English translations) used in Experiment 1

<i>Object nouns</i>	<i>Event nouns</i>	<i>One-argument verbs</i>	<i>Two-argument verbs</i>
Accento (Stress)	Arresto (Arrest)	Bollire (To boil)	Accendere (To light)
Angolo (Angle)	Brindisi (Toast)	Brillare (To shine)	Aggredire (To attack)
Banda (Band)	Brivido (Shiver)	Brindare (To toast)	Aprire (To open)
Fiocco (Bow)	Duello (Duel)	Bussare (To knock)	Arrestare (To arrest)
Formica (Ant)	Furto (Theft)	Cenare (To dine)	Baciare (To kiss)
Insalata (Salad)	Lotta (Wrestling)	Fischiare (To whistle)	Costruire (To build)
Lama (Blade)	Nuoto (Swimming)	Giurare (To swear)	Distuggere (To destroy)
Lati (Sides)	Riposo (Rest)	Miagolare (To mew)	Leccare (To lick)
Medaglia (Medal)	Scelta (Choice)	Nuotare (To swim)	Liberare (To free)
Orizzonte (Horizon)	Sconfitta (Defeat)	Pattinare (To skate)	Licenziare (To dismiss)
Pesca (Peach)	Sonno (Sleep)	Piangere (To cry)	Lucidare (To polish)
Profumo (Scent)	Sorpasso (Overtaking)	Ridere (To laugh)	Pugnalare (To stab)
Scontro (Crash)	Sosta (Halt)	Ruggire (To roar)	Pulire (To clean)
Timbro (Stamp)	Urlo (Crying)	Russare (To snore)	Pungere (To prick)
		Sbadigliare (To yawn)	Punire (To punish)
		Stirare (To iron)	Riparare (To repair)
		Sudare (To sweat)	Rubare (To steal)
		Suonare (To play [an instrument])	Scavare (To dig)
		Urlare (To cry)	Scegliere (To choice)
			Spedire (To send)

APPENDIX B

List of the object nouns, event nouns, and corresponding verbs (and English translations) used in Experiment 2

<i>Object nouns</i>			
Autista (driver)	Camionista (truck driver)	Muratore (mason)	Registratore (recorder)
Barista (barman)	Dentista (dentist)	Parlamento (parliament)	Sciatore (skier)
Batteria (battery)	Giornale (newspaper)	Pescheria (fish-shop)	Segretaria (secretary)
Biancheria (linen)	Minatore (miner)	Prestigiatore (conjurer)	Temporale (storm)
Cacciatore (hunter)	Mobili (furniture)	Pugnale (dagger)	Viale (avenue)
<i>Pairs of semantically related event nouns and corresponding verbs</i>			
<i>Set 1</i>		<i>Set 2</i>	
<i>Event nouns</i>	<i>Corresponding verbs</i>	<i>Event nouns</i>	<i>Corresponding verbs</i>
Abbraccio (hug)	Abbracciare (to hug)	Stretta (grasp)	Stringere (to grasp)
Acquisto (purchase)	Acquistare (to purchase)	Furto (theft)	Rubare (to steal)
Ammirazione (admiration)	Ammirare (to admire)	Disprezzo (contempt)	Disprezzare (to despise)
Arresto (arrest)	Arrestare (to arrest)	Incarcerazione (committal)	Incarcerare (to jail)
Arruolamento (recruitment)	Arruolare (to recruit)	Congedo (leave)	Congedare (to discharge)
Assunzione (employment)	Assumere (to employ)	Licenziamento (dismissal)	Licenziare (to dismiss)
Combattimento (fight)	Combattere (to fight)	Sfida (challenge)	Sfidare (to challenge)
Confessione (confession)	Confessare (to confess)	Testimonianza (testimony)	Testimoniare (to testify)
Impiccagione (hanging)	Impiccare (to hang)	Fucilazione (shooting)	Fucilare (to shoot)
Liberazione (liberation)	Liberare (to free)	Cattura (capture)	Catturare (to capture)
Promozione (promotion)	Promuovere (to promote)	Bocciatura (failure)	Bocciare (to fail)
Pugnalata (stab)	Pugnalare (to stab)	Frustata (whipping)	Frustare (to whip)
Uccisione (murder)	Uccidere (to murder)	Ferimento (wounding)	Ferire (to wound)