



Beyond the Mental Lexicon: Evidence from Neuropsychology and Implications for the Morphosyntax/Semantics Interface

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ABSTRACT

This study on a patient with semantic dementia aimed at investigating the neuropsychological correlate of the morphosyntax/semantics interface. Patient MC presented with severe but selective impairments in both semantics and morphosyntax. Her pattern of performance of morphosyntactic tasks that specifically required access to certain semantic features revealed a dissociation between the morphosyntactically relevant components of word meaning and the referential meaning of words. These results provide the first evidence of a cognitive and neural independence of the two components of word meaning.

KEYWORDS: morphosyntax/semantics interface, neuropsychology, semantic dementia.

1. *Word meaning and the morphosyntax/semantics interface*

Correspondences between semantic features and morphosyntactic behavior have been noted by researchers in linguistics and related fields dating at least as far back as Pāṇini.

These correspondences are hard to be accounted for as occurring by chance. Rather, they appear to be a sort of linking regularities, which have a strong crosslinguistic validity (Carter, 1988; Fillmore, 1968; Levin and Rapaport Hovav, 1995; Tenny, 1994).

A question arises here: what is the nature of the semantic properties associated with specific morphosyntactic features? What does a verb like *arrivare* “to arrive”, for instance, have in common with a verb like *morire* “to die”? They denote different events; nevertheless, they share specific morphosyntactic features. In languages like Italian, for instance, they select the same auxiliary verb (i.e., *essere* “to be”) in compound tenses and have past participle (PP) agreement with the subject (i.e., the PP takes an ending that agrees in gender and number with the subject): *Maria è arrivata (a casa)* “Maria went [lit. has gone] (home)”, *Maria è morta* “Maria died [lit. has died]”.

One might merely claim that identical morphosyntactic rules are incorporated into both lexemes (*arrivare* “to arrive” and *morire* “to die”) and, therefore, acquired along with them (Perlmutter, 1983; Perlmutter and Rosen, 1984; Burzio, 1986).

However, a number of questions arises. Why do they share some morphosyntactic features, but not others? How can we account for the fact that the same morphosyntactic behavior is shared by verbs denoting different events? Why are specific morphosyntactic features common to certain verbs as opposed to others?

One possibility to address these questions is to claim that the principle underlying morphosyntactic representations is arbitrary (Rosen, 1984; Perlmutter, 1989). The strongest evidence for assuming this is the existence of verbs with similar meanings but different morphosyntactic features – and viceversa – either within or across languages: for instance, in either Italian or English *russare* “to snore” and *arrossire* “to blush”, both of which refer to bodily processes, are associated with different morphosyntactic patterns (Sorace, 2000; Tenny, 1994).

However, word semantics is composite and not homogeneous in nature, and certain components of word meaning are relevant to morphosyntax, while others are not (Vendler, 1967; Dowty, 1979; Pinker, 1989; Croft, 1990; Van Valin and LaPolla, 1997; Levin and Rappaport Hovav, 1995).

The observation that words referring to totally different notions, such as *arrivare* “to arrive” and *morire* “to die”, share specific morphosyntactic patterns rules out a referential semantic account for similarities in morphosyntax. Rather, morphosyntactic patterns appear to be governed by a different type of semantic components, which we call Lexical Semantics (in Levin and Rappaport Hovav’s terms: Levin and Rappaport Hovav, 1995; Sorace, 2004, among many others).¹

Referential Semantics (RS) corresponds to the denoting meaning of words, that is, the semantic components determining their reference. The verb *to die*, for instance, refers to stopping living or existing; the verb *to walk* refers to moving along by lifting and setting down each foot in turn.²

¹ Lexical Semantics here refers to the semantic properties operating at the morphosyntax/semantics interface: that is, the semantic components of word meaning determining (or codetermining) essential morphosyntactic consequences. I wish to thank Pier Marco Bertinetto, for suggesting the new term “Operational Semantics”, that we would like to propose here for the morphosyntactically relevant components of word meaning.

² On the mapping relationships between words and extralinguistic entities, including the

Lexical Semantics (LS), instead, corresponds to more abstract properties defining the Logical Structure of words. The Logical Structure of *to die*, for instance, can be formally represented as: BECOME state' (x); the Logical Structure of *to walk* as: activity' (x).³ *To die* denotes an event which occurs independently of the subject's control and necessarily entails a specified endpoint, corresponding to a change of state of the subject: *John died*: BECOME state' (John) = BECOME died' (John). *To walk*, instead, denotes an activity unfolding under the subject's control, with no specific delimitation or final state. In this activity, «any part of the process is of the same nature of the whole» (Vendler, 1967: 101): *John walked*: activity' (John) = walk' (John).

Verbs like *to die* are telic and unagentive, as opposed to verbs like *to walk*, which are atelic and agentive. Telicity and agentivity are lexical semantic properties.

Lexical semantic properties are shared by words, independently of differences or similarities between their RS. *To die* and *to collapse*, for instance, denote different events: *the man died* vs. *the roof collapsed*; nevertheless, both verbs are telic and unagentive. Also *to walk* and *to talk* have different RS: *the boy walked around the city* vs. *the professor talked about the Indo-European verbal system*; nevertheless, both verbs are atelic and agentive. On the other hand, both *to snore* and *to blush* denote bodily processes and, therefore, refer to the same referential semantic field, but *to snore* is atelic, whereas *to blush* is telic: the former denotes an undelimited process, whereas the latter includes the final state of becoming red.

Morphosyntactic systems are sensitive to the distinction between RS and LS. Specific morphosyntactic patterns, indeed, are governed by LS, independently of RS. Words denoting different events but sharing specific lexical semantic properties show identical morphosyntactic features, as opposed to words having distinct lexical semantic properties. There appear to be striking lexical semantic regularities in the composition of classes of

so-called «inferential» and «referential» abilities and on the distinction between «dualistic» and «externalistic» view on semantics, see also MARCONI (1997), MICELI *et al.* (1991). Referential Semantics includes the information necessary to map both the real world to words and words to the real world or, rather, to the cognitive representation of it.

³ The 'x' in parenthesis indicates the first (or external: ZUBIZZARRETA, 1987; RAPPAPORT and LEVIN, 1988; TENNY, 1994; LEVIN and RAPPAPORT HOVAV, 1995) argument of predicates. Here we use simplified formulae of verb Logical Structure. For more detailed formulae and for further discussions of issues regarding Logical Structures and formal representations, see DOWTY (1979), VAN VALIN (1990), VAN VALIN and LAPOLLA (1997), VAN VALIN (2005), CROFT (2012), among others.

words sharing the same morphosyntactic patterns, «regularities that are manifested across languages in impressive similarities» (Levin and Rappaport Hovav, 1995: 2).

A merely syntactic explanation does not apply to all distributional patterns. Let us consider, for instance, the distribution of the temporal adverbials ‘in X time’ and ‘for X time’, in languages like English or Italian, in sentences such as *the man died in/*for an hour* vs. *the man walked for/*in an hour* (Bertinetto and Delfitto, 2000). *To die* selects ‘in X time’, as opposed to *to walk*. The syntactic frame is identical in both sentences; in addition, both *to die* and *to walk* are compatible with either *for* or *in*: *the man died for his country*, *the man walked in an unusual way*. Therefore, the principle underlying the distribution of the two different patterns cannot be purely syntactic in nature. Rather, the syntactic representations appear to be semantically driven. It is possible to identify the lexical semantic properties governing the selection of ‘in X time’, as opposed to ‘for X time’. In fact, the temporal adverbial ‘in X time’, which has a delimiting value, occurs only with telic verbs denoting a delimited event, such as *to die*, as opposed to atelic verbs, such as *to walk*, which denotes an event with no specific delimitation. One might again suppose that different syntactic rules are incorporated into verbs. However, this hypothesis cannot account for the compositional nature of actionality: *the soldier killed two enemies in ten minutes/*for ten minutes*, *Mary ate eighty grams of spaghetti in ten minutes/*for ten minutes* vs. *the soldier killed enemies *in ten minutes/for ten minutes*, *Mary ate spaghetti *in ten minutes/for ten minutes*. In these sentences, the actionality of verb predicates is determined by object quantification (Van Valin, 1990; Verkuyl, 1972): sentences involving a quantified object refer to a telic event, whereas sentences involving an uncountable, bare plural or mass object refer to an atelic event. Therefore, ‘in X time’ is compatible only with the representation of a telic event, either when telicity is inherent in the verbal lexeme, or when it is determined at the verb phrase (VP) level, and thus depends on the verb, its object and other actionally relevant elements in the VP (Tenny, 1994).

As regards nouns, a well-known example of distributional generalizations over morphosyntactic elements, which are unlikely to rely on a purely syntactic principle, concerns the distinction between mass/uncountable (uncount) nouns, such as *latte* “milk” or *fogliame* “foliage” and countable (count) nouns, such as *cane* “dog” and *tavolo* “table”: *I’d like some/*a milk, please*, *there is a/*much dog which barks*. Nouns like ‘dog’, which are able

to be counted, can take both definite and indefinite article, plural markers and quantifiers that necessarily denumerate (e.g., ‘one’, ‘two’, ‘many’, ‘each’), but cannot take quantifiers that do not necessarily denumerate (e.g., ‘little’, ‘much’). Viceversa, nouns that are not able to be counted, such as ‘water’, ‘milk’ and ‘sand’ show the opposite morphosyntactic behavior (Chierchia, 1998a, 1998b, 2010; Krifka, 1995, Rothstein, 2010).

At least two universal patterns support the hypothesis that semantic principles underlie the distinction between mass/uncount and count nouns:

- 1) there are no languages in which numerals combine with mass nouns (independently of whether or not languages have plural markers for mass nouns): the type **tre sangui* “three bloods” does not occur;
- 2) there are no languages in which nouns denoting liquids are countable, independently of differences in language specific criteria for establishing the distinction between mass/uncount and count nouns.

The observations made so far lead to suppose that specific morphosyntactic features are semantically determined (Perlmutter, 1978; Chomsky, 1981, 1986; Tenny, 1994; Levin and Rappaport Hovav, 1995), and raise the question whether the semantic properties critical for morphosyntax are dissociable from the referential meaning of words.

Assuming that LS governs morphosyntax in a specified way, independently of RS, may also account for words with variable morphosyntactic behavior (Dowty, 1979; Levin and Rappaport Hovav, 1995). In languages like Italian or Dutch, for instance, verbs like ‘to run’ show two distinct patterns of compound tenses. In one pattern, they select ‘to have’ as auxiliary verb and do not have PP agreement with the subject (i.e., in Italian, for instance, the PP takes the unmarked masculine singular ending *-o*): It. *Maria ha corso nel parco* “Maria has run in the park”. In the other, they select ‘to be’ as auxiliary verb and do have PP agreement with the subject: *Maria è corsa a casa* “Maria has run home”. Referential meaning being the same, the former construction refers to an atelic event, with no delimitation or end state, whereas the latter refers to a telic event, necessarily including a specified endpoint. Therefore, the alternation between these two morphosyntactic patterns appears to be governed by differences in LS, distinguishing between two different representations of the referential meaning of ‘to run’. Significantly, the semantic properties that govern this alternation across variable behavior verbs determine the distribution of the same cluster of morphosyntactic fea-

tures across verbs with exclusive morphosyntactic behavior (Sorace, 2011, 2004, 2000; Centineo, 1996; Van Valin, 1990).

To account for verbs like *correre* “to run”, the theory that rejects any alignment between semantic and morphosyntactic features and, therefore, assumes that morphosyntax is solely lexically determined (Rosen, 1984), has to assign more than one lexical entry to certain verbs, thus resulting in an unwelcome multiplication of lexical entries.

On the contrary, the thesis of a mapping relationship between lexical semantics and morphosyntax not only is grounded in a principle of economy, since it rules out unwelcome multiplications of entities to account for phenomena like those described above, but also has a significantly large scope of application, insofar as it may explain phenomena that might appear unrelated. It has been shown, for instance, that distinct morphosyntactic structures tend to be acquired simultaneously, in both L1 and L2 acquisition, when they function as markers of the same lexical semantic property (e.g., telicity: Tenny, 1994; Slabakova, 2001; van Hout, 1998; Schulz and Penner, 2002; Hodgson, 2010).

The series of linguistic phenomena which are morphosyntactically represented but semantically determined is extremely long and largely debated in the literature (see Levin and Rappaport Hovav, 1995, 2001; Tenny, 1994; Zaenen, 1993; Haspelmath, 1993; Alexiadou *et al.*, 2004; Aikhenvald, Dixon and Onishi, 2001; Sorace, 1995, 2000; Centineo, 1996; Krifka, 1998; Chierchia, 2010; among many others).

A question arises here: does the distinction between RS and LS have a universal foundation? A possible way to address this question is to investigate whether LS is cognitively and neurally distinguishable from RS.

2. The Referential Semantics/Lexical Semantics distinction: Evidence from Neuropsychology

Evidence of a neuropsychological dissociation between RS and LS comes from a recent study on a patient with Semantic Dementia (SD: for further data on the same patient, see Papagno *et al.*, 2009; Romagno *et al.*, 2010). SD patients offer a good opportunity to investigate this dissociation, because of their impairment in accessing word RS. They typically fail word comprehension tasks and various kinds of semantic questionnaire, and are unable to name objects, concepts, events or people, whether in response to a

stimulus or in spontaneous speech (Hodges and Patterson, 2007; Patterson *et al.*, 2007, Neary *et al.*, 1998).

Prior studies that specifically investigated morphosyntactic processing in SD patients focused almost exclusively on morphological or syntactic phenomena which are independent of LS.

Wh-movement (Breedin and Saffran, 1999), for instance, is not sensitive to lexical semantic properties. Indeed, it perfectly applies to either a sentence like *John murdered this girl: Who did John murder?*, or a sentence like *The book costs 20 dollars: What does the book cost?*, despite differences in the LS of verbs.⁴ Similarly, the following phenomena, largely discussed in the literature on SD patients, have a purely morphological or syntactic basis: the structures following Locality Principles (Cotelli *et al.*, 2007; Chomsky, 1981); the subject-auxiliary inversion (Tyler *et al.*, 1997; Breedin and Saffran, 1999; Rochon *et al.*, 2004); the use of *to do* as auxiliary verb (Schwartz *et al.*, 1979; Breedin and Saffran, 1999); word order in cases like *I read the book* vs. **I read book the*, *I went there to choose something* vs. **I went there choose to something* (Tyler *et al.*, 1997); verb constructions like *I was making a sandwich* vs. **I had making a sandwich* (Tyler *et al.*, 1997); the distribution of regular and irregular inflectional markers, such as *talk – talked*, *sing – sang* (Schwartz *et al.*, 1979; Patterson *et al.*, 2001; Tyler *et al.*, 2004; Benedet *et al.*, 2006). The morphological contrasts *sang* vs. *talked* and *sank* vs. *died* ultimately rely on word history, independently of LS: *sang* and *sank* show the same pattern of past-tense formation, although they belong to distinct verb classes as established on lexical semantic grounds: *to sing* is an atelic activity verb, and so is *to talk*; *to sink*, instead, is telic, and so is *to die*. Nevertheless, *to sing* bears the same past-tense marker as *to sink*, as opposed to *to talk* and *to die* (Jespersen, 1942; Bybee and Moder, 1983).

Prior studies focusing on morphosyntactic phenomena that are sensitive, to a certain extent, to LS reported experiments in which it is difficult to identify whether the patients' pattern of performance has a lexical semantic constraint. Passive conversion, for instance, may be licensed by lexical semantic properties of verbs (Jackendoff, 1972; Fici Giusti, 1994): in languages like English or Russian, in fact, it perfectly applies to sentences like *John has murdered this girl: This girl has been murdered by John*, while

⁴ The accomplishment verb *to murder* is dynamic, agentive and telic, as it necessarily entails a highly affected argument, whereas the state verb *to cost* is non-dynamic, unagentive and atelic, with no affected argument (VENDLER, 1967; DOWTY, 1979; BERTINETTO, 1986; VAN VALIN and LAPOLLA, 1997; BONOMI and ZUCCHI, 2001).

it does not apply to sentences like *The book costs 20 dollars: ?*20 dollars are cost by the book*.⁵ However, tasks like the grammaticality judgement of badly formed passive sentences, which do not include the preposition *by* preceding the agent (Breedin and Saffran, 1999), or guided picture description, in which the patient is provided with the correct verb in the infinitive form and had to produce the passive construction, but all the verbs used in the task can bear passivization (Benedet *et al.*, 2006), can test the patients' access to the morphosyntactic material subserving passive constructions, but cannot test their access to the lexical semantic properties governing the distribution of these constructions. Only tasks involving verbs with different LS, which exclusively allows or disallows passivization, might test patients' access to the semantic properties relevant to morphosyntax.

Moreover, several studies on SD patients (Schwartz *et al.*, 1979; Breedin and Saffran, 1999; Rochon *et al.*, 2004) investigated the thematic role assignment, a morphosyntactic phenomenon which is semantically determined, as thematic roles depend on verb semantics (Dowty, 1991; Van Valin and LaPolla, 1997; Langacker, 2008). However, they used sentence-picture matching tasks, in which it is difficult to disentangle LS from syntactic information. The patients' patterns of performance, indeed, were triggered by syntactic roles as encoded by the argument position in the sentence. This clearly appeared when the sentence and the depicted (or enacted action) did not match: if the patients were shown the picture of a dog chasing a cat and told *the cat is chasing the dog; show me the cat*, they pointed the chasing animal in the picture (i.e., the dog). Therefore, we might suppose that patients accessed morphosyntactic information necessary to make their choice on the basis of syntactic roles (e.g., the position of subject, verb and object in the sentence) – which is consistent with patients' high success rate in purely morphosyntactic tasks (Schwartz *et al.*, 1979) – and, furthermore, that little referential semantic information was required to perform the task (Breedin and Saffran, 1999: 554; Schwartz *et al.*, 1979: 295). However, this task cannot test whether the patients accessed the lexical semantic properties determining the thematic roles of verb arguments.⁶ Syntactic roles are, in fact, independent of thematic roles (also called semantic roles or thematic

⁵ On differences in LS between *to murder* and *to cost*, see fn. 4.

⁶ Significantly, the patients replicated their pattern of performance in tasks including constructions with spatial prepositions and comparative adjectives, to which lexical semantic properties like those determining the thematic roles of verb arguments are irrelevant (SCHWARTZ *et al.*, 1979; BREEDIN and SAFFRAN, 1999).

relations):⁷ a syntactic subject may correspond to either a patient (*John died*) or an agent (*John is walking*), and a patient may figure as either a syntactic subject (*John died*) or a syntactic object (*Mary killed John*).⁸ The fact *per se* that SD patients were able to recognize the syntactic roles and to link them to the participants in the picture (or in the enacted scene) cannot tell us whether they accessed LS and, consequently, distinguished between different thematic roles. Only a task which allows comparison of distinct lexical semantic properties determining the number and the thematic roles of verb arguments may test patients' access to LS.⁹

In conclusion, a systematic investigation of distributional patterns of morphosyntactic features determined by LS is still lacking in neuropsychological studies.¹⁰

We tested our patient, MC, through a series of morphosyntactic tasks that specifically required access to the lexical semantic properties determining the morphosyntactic patterns involved in each task.

The aim of the study was to investigate whether MC's impairment at RS was necessarily accompanied by an impairment at LS or, rather, the two components of word meaning were neurally distinguishable.

2.1. Morphosyntactic tasks

The patient was provided with written Italian sentences (also read aloud by the examiner) and requested to respond in either written or oral modality.

⁷ On the *continuum* of thematic roles and on different terminologies referring to these notions, see JACKENDOFF (1976), FOLEY and VAN VALIN (1984), VAN VALIN (1990), DOWTY (1991), VAN VALIN and LAPOLLA (1997), among others.

⁸ I only wish to mention that the direct object of a transitive construction never has the role of agent, even if it does not necessarily correspond to a prototypical undergoer argument (VAN VALIN and LAPOLLA, 1997).

⁹ On a potential interaction between animacy and argument coding, affecting thematic role assignment and morphosyntactic complexity, and on the role of animacy (a referential semantic property) as epiphenomenon of agentivity (a lexical semantic property), see SAFFRAN *et al.* (1998); CAPLAN *et al.* (1994); MACDONALD *et al.* (1994); TRUESWELL *et al.* (1994); ROMAGNO (2005), (2006), (2007).

¹⁰ Among studies which investigated morphosyntactic processing in SD, independently of LS, several studies reported cases of SD patients showing unaffected morphosyntax (see COTELLI *et al.*, 2007; TYLER *et al.*, 2004; BREEDIN and SAFFRAN, 1999; NEARY *et al.*, 1998; HODGES and PATTERSON, 1996, among others.), whereas others provided evidence of SD patients presenting with difficulty in morphological and/or syntactic processing (METEYARD and PATTERSON, 2009; BENEDET *et al.*, 2006; PETERSON and MACDONALD, 2006; PATTERSON *et al.*, 2001). A question that has not yet been solved is whether and how semantics interacts with other aspects of language production.

Task 1. Temporal adverbials

In the first task, the patient had to complete sentences like *Il cane ha abbaiato ... (IN/PER) un'ora* “The dog barked ... (IN/FOR) an hour”; *Mario è morto ... (IN/PER) tre giorni* “Mario died ... (IN/FOR) three days”, by choosing between the two words written in parenthesis. As we have shown above, the distribution of these two patterns is governed by telicity: ‘in X time’, which has a delimiting value, occurs only with telic verbs.¹¹ The patient’s responses were 100% correct.

Task 2. Derivational suffix: ‘-tore’

In the second task, the patient had to express an acceptability judgement (via a binary choice: yes/no) on sentences including agent nouns derived from verbs via the suffix *-tore*: *Luigi è un serio esistitore* “Luigi is a serious exister”, *Mario è un gran lavoratore* “Mario is a good worker”.

This morphological phenomenon distinguishes verbs which have an undergoer subject (patient or theme), such as *morire* “to die” or *appartenere* “to belong”, from verbs which do not, such as *viaggiare* “to travel” and *lavorare* “to work”. Verbs with an undergoer subject do not produce agent nouns via the suffix *-tore*: *viaggiatore* “traveler” vs. **appartenitore* “*belonger” (Bisetto, 2006).¹² The regular morphological and phonotactic pattern of word formation applies to both *viaggiatore* “traveler” and **appartenitore* “*belonger”. They differ, instead, in the LS of verbs. The patient’s responses were 100% correct.

Task 3. Imperative

In the third task, the patient was asked to express an acceptability judgement (via a binary choice: yes/no) on sentences including a verb in the imperative mood: *Cammina!* “Walk!”, **Esisti!* “*Exist!”.

Imperative is selectively distributed across verbs, depending on their agentivity. Imperative, in fact, requires the argument corresponding to the syntactic subject to have the control of the event and, therefore, occurs with agentive verbs, such as *camminare* “to walk”, but does not occur with unagentive verbs, such as *esistere* “to exist” (Bertinetto, 1986). The patient’s responses were 100% correct.

¹¹ On different uses of the temporal adverbial ‘per X time’ in combination with telic (accomplishment and achievement) verbs, see BERTINETTO (1986).

¹² Italian suffix *-tore* is also used to derive *nomina instrumenti* (e.g. *contenitore* “container”) from verbs: in this case, verb agentivity is, obviously, not required.

Task 4. Present Progressive

In the fourth task, the patient had to express an acceptability judgement (via a binary choice: yes/no) on sentences including a verb in the present progressive: *Luigi sta camminando lungo il fiume* “Luigi is walking along the river”, *Anna sta possedendo una grande intelligenza* “*Anna is possessing a great intelligence”.

The ability of verbs to be used in the present progressive depends on their degree of dynamicity. This lexical semantic property distinguishes verbs denoting dynamic processes, like *camminare* “to walk” and *mangiare* “to eat”, from state verbs, like *possedere* “to possess” and *esistere* “to exist”. State verbs, typically, do not have progressive tense (Bertinetto, 1986; Dowty, 1979). The patient’s responses were 100% correct.

Task 5. Auxiliary selection and past participle agreement with the subject

In the fifth task, the patient had to complete sentences like *I soldati ... (SONO/HANNO) mort... (O/I)* “The soldiers (ARE/HAVE) died”, *Gli operai ... (HANNO/SONO) lavorat... (I/O)* “The laborers (HAVE/ARE) worked”. She had to select the right auxiliary between *avere* “to have” and *essere* “to be”, and the right PP ending between the two forms written in parenthesis (one form corresponded to the unmarked masculine singular ending ‘-o’, the other agreed in gender and number with the subject).

In Italian (and other languages: see Sorace, 2000, 2011; van Hout, 2004; Van Valin, 1990; Legendre, 1989; among many others), auxiliary selection in compound tenses and PP agreement with the subject split intransitive verbs into two classes.

Unaccusative verbs select the auxiliary *essere* “to be” and have PP agreement with the subject:

<i>i soldati</i>	<u>sono</u>	<i>mort</i>
the soldiers	to be.PRES.IND.3pl	died.PP.masc.pl
“the soldiers have died”		

Unergative verbs, instead, select the auxiliary *avere* “to have” and lack PP agreement with the subject:

<i>gli operai</i>	<u>hanno</u>	<i>lavorato</i>
the laborers	to have.PRES.IND.3pl	worked.PP.masc.sg ¹³
“The laborers have worked”		

¹³ PRES = present, IND = indicative, PP = past participle, masc = masculine, pl = plural, sg = singular.

The distribution of the two morphosyntactic patterns is governed by a cluster of lexical semantic properties of verbs (i.e., telicity, agentivity, affectedness of the subject: Sorace, 1995, 2000; Levin and Rappaport Hovav, 1995). Essentially, verbs that have a state predicate in their Logical Structure, that is either verbs denoting a state/location, like *stare* “to stay” and *esistere* “to exist”, or verbs describing a change of state/location, like *morire* “to die” and *arrivare* “to arrive” show the unaccusative pattern. Verbs that do not have a state predicate in their logical structure, that is verbs denoting activities, which do not entail any change of state/location, such as *camminare* “to walk” and *parlare* “to talk” show the unergative pattern.¹⁴ The patient’s responses were 100% correct.

Task 6. Mass Nouns vs. Count Nouns

In the sixth task, the patient had to complete sentences including either a mass/uncount noun or a count noun, such as *c’è ... (UN/MOLTO) cane che abbaia* “there is ... (A/MUCH) dog which barks”, *Vorrei ... (UN/DEL) latte per favore* “I’d like ... (A/SOME) milk, please”, by choosing between the two words written in parenthesis. The two alternatives corresponded to different kinds of determiner and/or quantifier. Stimuli used in this task belong to Semenza’s battery (Semenza *et al.*, 1997).

As we have shown above, the distribution of nominal determiners and quantifiers depends on the countability of nouns.¹⁵ The patient’s responses were 98,27% correct.

¹⁴ One could again suppose, however, that such morphosyntactic patterns are analyzable as barely formal rules incorporated into lexemes in an arbitrary way – that is excluding any non-formal feature accounting for them – and therefore acquired and stored along with lexemes (ROSEN, 1984; PERLMUTTER, 1989; LEVELT *et al.*, 1989). Nevertheless, the observation that despite MC’s severe impairment in accessing lexical items, her success rate in all the morphosyntactic tasks discussed so far was remarkably high, leads to suppose that the access to lexical items is distinguishable from the access to the rules underlying the morphosyntactic behavior of those items (CARAMAZZA, 1988). Moreover, as we have shown above, it is possible to identify properties belonging to a different level from morpho-syntax (i.e., LS), that account for specific morphosyntactic features of words with even different RS. The patient’s access to these properties was preserved, despite her severe referential semantic deficit, on one hand, and her difficulty in purely morphosyntactic processing, on the other (see below). It is worth noting that the patient’s response score in task 5 was remarkably high even with sentences including variable behavior verbs like *correre* “to run”.

¹⁵ Also the dissociation noted by GARRARD *et al.* (2004) between semantic and syntactic properties of mass vs. countable nouns might be explained as a dissociation between RS and LS, as only LS appears to be relevant to the morphosyntactic behavior of nouns.

2.2. Referential semantic tasks

The patient's access to RS of verbs and nouns included in the six tasks described above was previously tested via a vocabulary task (oral definition), like the one included in the Wechsler Adult Intelligence Scale (WAIS), and compared with five neurologically-unimpaired control subjects, matched for age, education and sex. Her performance was extremely poor, as reported in Table 1.

Referential Semantics		
Task 1-6		
Word Comprehension		
	Verbs	Nouns
MC's Success Rate	30.3%	28.5%

Table 1. *MC's access to RS of verbs and nouns used in the morphosyntactic tasks 1-6*

2.3. Results, discussion and conclusions

Despite a severe impairment in accessing the referential semantic components of words, patient MC was perfectly able to access the lexical semantic features determining the morphosyntactic behavior of words, as revealed by her remarkably high success rate in performing morphosyntactic tasks that specifically required access to LS. MC's pattern of performance, therefore, revealed preserved LS, despite a severely impaired RS. One could again suppose that MC's pattern of performance relies on a general dissociation between semantic and formal features. In order to test this hypothesis, we asked the patient to perform morphological tasks that did not require access to LS, such as the production of inflectional forms, which are only lexically controlled. She was provided with written sentences (also read aloud by the examiner) including incorrect verb forms, such as *ieri Mario ha corruto nel parco* (*corruto* instead of *corso*, PP of *correre* "to run") "yesterday Mario has run in the park", *Filippo venirà domani* (*venirà* instead of *verrà*, future tense of *venire* "to come") "Filippo will come tomorrow", alternating with sentences including correct verb forms, and asked to recognize the incorrect forms and to produce the correct ones. *Corso* vs *corruto*, *venirà* vs *verrà* refer to inflectional patterns that ultimately rely on historical changes of word forms and are independent of LS. In this task, MC's percentage of errors was

up to 40%. Therefore, these results suggest that the patient's processing of formal features was not uniformly preserved, since she performed well only the tasks that specifically required access to LS. Alternatively, her low success rate in morphological tasks with inflectional paradigms might simply demonstrate the independence of morphology from syntax, without testing the dissociation between lexical semantic and formal features within the syntactic domain. However, the observation that MC's processing of a purely syntactic rule, such as word order, was extremely poor even in spontaneous speech supports the hypothesis that both morphology and syntax were not uniformly preserved, and that her pattern of performance of the morpho-syntactic tasks described in §2.1, which specifically required access to LS, was not related to a general dissociation between semantics (impaired) and morphosyntax (spared), but rather relied on a dissociation between RS (impaired) and LS (spared).

In order to rule out that the patient's performance of the morphosyntactic tasks one through six relied on her possibly preserved episodic memory and was, therefore, related to the higher frequency of certain combinations of words relative to others, we tested her through all the same tasks, by using sentences including unusual/impossible combinations, such as *The dog talked *in/for an hour*, *The soldier killed a stone in/*for two minutes*. MC replicated her success rate across all the six tasks.

To sum up, MC's pattern of performance did not reveal a general dissociation between semantics and morphosyntax, considered as homogeneous blocks. Rather, it revealed a dissociation between the semantic component determining word reference (RS) and the semantic component relevant to morphosyntax (LS).

It is commonly said that retrieving a word from the mental lexicon, in addition to retrieving the word's sound structure, entails access to two types of knowledge: the word's meaning and its so-called «grammatical» properties. The results of the present study show that:

- 1) these two types of knowledge comprise subtypes, as word meaning includes two different components (RS and LS), at least, and 'grammar' includes both morphosyntactic features which are semantically determined and morphosyntactic features which are not;
- 2) the components of word meaning that are relevant to morphosyntax (LS) are separately stored and accessible from the semantic components determining the reference of words (RS);

- 3) deficits in language production and comprehension may selectively involve RS vs. LS, as well as purely formal vs. semantically determined «grammatical» properties.

In conclusion, this study provides, for the first time, an indication of the cognitive and neural separation of the morphosyntactically relevant component of word meaning (LS) and the referential meaning of words (RS), as it offers clear evidence that the distinction between LS and RS has a neuropsychological correlate.

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