

Evidence from neuropsychology on verb features: The case of a patient with Semantic Dementia

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Abstract

The aim of this study is to investigate whether Referential Semantics (RS) and Lexical Semantics (LS) are independently represented in the brain. We report the case of a Semantic Dementia patient who, despite a severe impairment in accessing verb RS, was perfectly able to access verb lexical semantic features governing specific morphosyntactic operations. This pattern of performance constitutes the first clear evidence that the distinction between RS and LS, that operates in language, does have a neuropsychological correlate.

1 Introduction

Verb meaning includes two different components at least: Referential Semantics (RS) and Lexical Semantics (LS) (in Levin & Rappaport Hovav's terms: Levin & Rappaport Hovav, 1995, among others).

RS determines verb reference: dying, for instance, refers to stopping living or existing; walking refers to moving along by lifting and setting down each foot in turn. LS, instead, corresponds to more abstract features, like agentivity and telicity, that are shared by verbs, independently of differences or similarities between their RS. Dying is telic (it entails a specified endpoint corresponding to the change of state of the subject) and unagentive (the subject does not have the control of the event). And so is collapsing, even though dying and collapsing do not

have the same RS: “the man died” vs. “the roof collapsed”. Walking, instead, is atelic (it denotes an event unfolding over time with no final state or specific delimitation) and agentive (the subject does have the control of the event). And so is talking: even though walking and talking do not have the same RS: “the boy walked along the river” vs. “the professor talked about Higgs boson”.

The question that we address here – and that has not yet been addressed – is whether these two components of verb meaning are independently represented in the brain.

Since LS governs morphosyntax in a specified way independently of RS, we are able to investigate the neural dissociation between the two semantic components by testing morphosyntactic processing.

Features like telicity and agentivity are morphosyntactically relevant, indeed: there appear to be striking lexical semantic regularities in the composition of classes of verbs sharing the same morphosyntactic patterns, “regularities that are manifested across languages in impressive similarities” (Levin & Rappaport Hovav, 1995:2).

We can fairly claim that these morphosyntactic patterns are semantically determined (Levin & Rappaport Hovav, 1995, 2001; VanValin, 1990, Van Valin & LaPolla, 1997; Tenny, 1994; Croft, 1990; Dowty, 1979, 1991; Chomsky, 1981, 1986; Perlmutter, 1978).

Let us consider, for instance, the distribution of the temporal adverbials “in X time” and “for X time” in sentences like “the man died in/*for an hour” vs. “the man walked for/*in an hour”. Dying selects “in X time”, as opposed to walking.

Does the behavior of the two verbs depend on syntactic differences? Or rather, are these syntactic representations semantically driven?

The syntactic frame is identical in both sentences; in addition, both dying and walking are compatible with either “for” or “in”: “the man died for his country”, “the man walked in an unusual way”. However, the temporal adverbial “in X time”, that has a delimiting value, occurs only with telic verbs like “to die” which denotes a delimited event, as opposed to atelic verbs like “to walk” which denotes an event with no specific delimitation. Thus, syntactic features being equal, it is possible to identify the components of verb meaning that give rise to a given pattern as opposed to the other.

The list of verbal phenomena that are morphosyntactically represented but semantically determined is significantly long and well-known in the literature (Levin & Rappaport Hovav, 1995, 2001; Zaenen, 1993; Haspelmath, 1993, 2001; Alexiadou et al. 2004; Aikhenvald-Dixon-Onishi, 2001; Sorace, 2000; Centineo, 1996).

We tested our Semantic Dementia (SD) patient through a series of morphosyntactic tasks that specifically required access to the lexical semantic features determining the morphosyntactic representations involved in each task.

Patients with SD offer a unique opportunity to investigate the dissociation between RS and LS: they typically show a severe impairment in accessing the RS of words, in the face of a good ability to produce well-formed sentences.

Previous studies on SD patients – and, more generally, on Fronto Temporal Dementia (FTD) patients (Breedin & Saffran, 1999; Cotelli et al. 2007; Tyler et al. 1997; Rochon et al. 2004; Schwartz, Marin & Saffran, 1979; Patterson et al. 2001; Tyler et al. 2004; Benedet et al. 2006; Neary et al. 1998; Hodges & Patterson 1996; Hodges et al. 1992; Meteyard & Patterson, 2009; Patterson & MacDonald, 2006, Lambon Ralph & Patterson, 2008; Visser et al. 2010) – almost exclusively focused on either RS or morphosyntactic patterns that are independent of LS, such as, for instance, the so-called ‘wh-movement’, that perfectly applies to either “John died” (“Who died?”) or “John talked” (“Who talked?”), even though dying and talking belong to different lexical semantic classes.

We investigated the patient access to LS, in order to see whether her severe impairment at RS was necessarily accompanied by an impairment at LS, or rather the two components of verb meaning were neurally distinguishable.

Here we provide the first evidence that the distinction between referential semantic and lexical semantic verb features, that operates in language, can give rise to a neuropsychological dissociation. Our patient presented with a severely damaged RS, but intact LS. Significantly, when tested on morphosyntactic operations which are not sensitive to LS, she did not perform well. Her percentage of errors was up to 40%, in the face of 100% correct responses in the morphosyntactic tasks requiring access to LS.

2 Case Presentation

Patient MC was previously reported by Papagno, Capasso & Miceli (2009), who found a reversal of the concreteness effect restricted to nouns. MC is an Italian 75-year-old, right-handed woman with 17 years of education. She worked as a teacher until 1995. MC suffers of Semantic Dementia, a neurodegenerative disease that belongs to the Fronto-Temporal Dementia (FTD) spectrum (Warrington, 1975; Neary, Snowden et al. 1998). She showed the typical pattern of an SD patient with regard to both neuropsychological behavior and neurological profile (Hodges and Patterson, 2007). At the time of our research, MC’s semantic deficit affected both the grammatical categories of Noun and Verb almost to the same extent and without any distinction between either concrete and abstract terms or animate and inanimate entities.

MC’s neuroimaging revealed a bilateral degeneration of the Anterior Temporal Lobes, with a greater atrophy on the left side at the earlier stages of the disease; the atrophy also progressively involved the insula and the frontal operculum bilaterally (Figure 1-2).

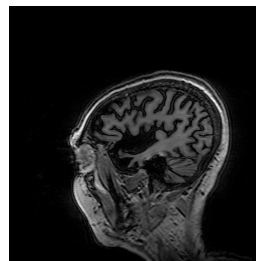


Figure 1

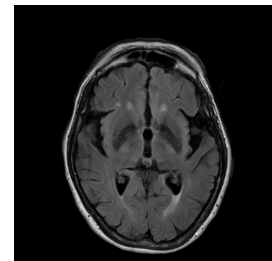


Figure 2

Figure 1 and 2. Marked atrophy involving bilaterally the temporal lobe, the insula, and the frontal operculum, more pronounced in the left hemisphere.

3 Methods and Results

3.1 Morphosyntactic Tasks

The morphosyntactic tasks that we used to test the patient's access to LS are summarized in Table 1. Each task specifically requires access to the property or the cluster of properties determining the morphosyntactic representations which are involved.

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

Task 1

The distribution of the temporal adverbials "in X time" and "for X time" allows to distinguish between telic verbs like "to die" and atelic verbs like "to talk": "in X time", that has a delimiting value, occurs only with verbs denoting a delimited event, like telic verbs, as opposed to atelic verbs which denote an event with no specific delimitation or final state: *Luigi è morto in/*per un giorno* "Luigi died in/*for a day" vs *Mario ha parlato per/*in un'ora* "Mario talked for/*in a hour".

Task 2

Imperative mood allows to distinguish between agentive and non-agentive verbs: since imperative requires the subject to have the control of the event, it occurs only with agentive verbs, such as "to walk": *Cammina!* "Walk!" vs **Esisti!* "Exist!".

Task 3

Present Progressive allows to distinguish between dynamic and non-dynamic verbs. Since progressive tense is a statement of dynamic process, it does not occur with states like "to possess", "to consist of": *Maria sta mangiando un gelato* "Maria is eating an ice-cream" vs **Anna sta possedendo una grande intelligenza* "Anna is possessing a great intelligence".

Task 4

"To be" as auxiliary verb in compound tenses and PP agreement with the subject (i.e. the PP takes an ending that agrees in gender and number with the subject) allow to distinguish between the intransitive verbs which do entail a state predicate in their logical structure – that is, intransitive verbs denoting either a change of state/location, such as "to arrive", or an inherent state/location, such as "to exist" – and the intransitive verbs which do not, such as "to work". These select "to have" and lack PP agreement with the subject (i.e. the PP takes the unmarked singular ending *-o*):

I soldati sono ("are") *arrivati*
"The soldiers arrived"

vs.

Gli operai hanno ("have") *lavorato*
"The laborers worked"

Task 5

Agent nouns with *-tore* allow to distinguish between verbs which require an UNDERGOER subject, like "to belong", "to die" (whose subject is in a given state/location or undergoes a change of state/location) and verbs which do not, like "to travel". The verbs requiring an UNDERGOER subject do not produce agent nouns via the suffix *-tore*: *viaggiatore* "traveler" vs. **appartenitore* "belonger".

3.2 Semantic Tasks

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

3.3 Referential Semantics vs Lexical Semantics

The patient's performance of the tasks testing her access to word RS was extremely poor, as reported in Table 2.

Referential Semantics		
Task 1-5		
Word Comprehension		
	Verbs	Nouns
MC's Success Rate	30.32%	28.5%

Table 2. MC's access to the RS of the verbs and the nouns used in the morphosyntactic tasks 1-5.

On the contrary, the patients's success rate in performing the tasks that specifically required access to the LS of the words involved in the morphosyntactic representations, was remarkably high, as shown in Table 3. Hence, we can conclude that the patient's pattern of performance revealed preserved LS, in the face of severely impaired RS (Table 4).

	Stimuli	Lexical Semantic Properties	Linking Rules
Task 1: Sentence Completion <u>Temporal Adverbials</u>	<i>Luigi è morto. . . (in/per) un giorno</i> “Luigi died. . . (in for) a day” <i>Mario ha parlato. . . (in/per) un’ora</i> “Mario talked. . . (in for) an hour”	Telicity	+Telicity = <i>in</i> X time –Telicity = <i>per</i> X time ¹
Task 2: Acceptability Judgement <u>Imperative</u>	<i>Cammina!</i> “Walk!” <i>Esisti!</i> “Exist!”	Agentivity	+Agentivity = +Imperative –Agentivity = –Imperative
Task 3: Acceptability Judgement <u>Present Progressive</u>	<i>Maria sta mangiando un gelato</i> “Maria is eating an ice-cream” <i>Anna sta possedendo una grande intelligenza</i> “Anna is possessing a great intelligence”	Dynamicity	+Dynamicity = +Pres.Progr. –Dynamicity = –Pres.Progr.
Task 4 Sentence Completion <u>Auxiliary Selection and Past Participle (PP) Agreement with Subject</u>	<i>I soldati... (sono/hanno) arrivati... (i/o)</i> “The soldiers... (are/have) arrived” <i>Gli operai. . . (sono/hanno) lavorat. . . (o/i)</i> “The laborers. . . (are/have) worked”	Event Structure (ES)	+State Predicate in the ES = “to be”, +PP agreement –State Predicate in the ES = “to have”, –PP agreement
Task 5 Acceptability Judgement <u>Derivational Suffix -tore</u>	<i>Andrea è un viaggiatore curioso</i> “Andrea is a curious traveler” <i>Mario è un serio appartenitore</i> “Mario is a serious believer”	Subject’s Semantic Role	ACTOR Subject = +Suffix <i>-tore</i> UNDERGOER Subject = –Suffix <i>-tore</i> ²

Table 1. Morphosyntactic tasks used to test MC’s access to verb LS features.

Morphosyntactic Behavior					
	Task 1 Temporal Adverbials	Task 2 Imperative	Task 3 Present Progressive	Task 4 Aux.Sel. and PP agreement	Task 5 Derivational Suffix <i>-tore</i>
MC’s Success Rate	100%	100%	100%	100%	100%

Table 3. MC’s success rate in the morphosyntactic tasks requiring access to verb LS features.

	Verbs	LS	RS
Task 1	<i>morire</i> vs. <i>parlare</i> “to die” vs. “to talk”	100%	20%
Task 2	<i>camminare</i> vs. <i>esistere</i> “to walk” vs. “to exist”	100%	33,3%
Task 3	<i>mangiare</i> vs. <i>possedere</i> “to eat” vs. “to possess”	100%	33,3%
Task 4	<i>arrivare</i> vs. <i>lavorare</i> “to arrive” vs. “to work”	100%	25%
Task 5	<i>viaggiare</i> vs. <i>appartenere</i> “to travel” vs. “to belong”	100%	40%

Table 4. MC’s success rate in the tasks testing her access to verb LS vs RS features.

¹ We refer to Bertinetto (1986) on different uses of the temporal adverbial “*per* X time” in combination with accomplishment and achievement verbs.

² The Italian suffix *-tore* is also used to derive *nomina instrumenti* (e.g. *contenitore* “container”) from verbs: in this case, verb agentivity, obviously, is not required. When *-tore*, instead, encodes an agent noun (*nomen agentis*), the ACTOR semantic role of the subject is required.

4 Discussion

Despite a severe impairment in accessing verb referential semantic features, MC was perfectly able to access the lexical semantic features determining the morphosyntactic behavior of verbs. One could again suppose that MC's pattern of performance relies on a general dissociation between semantics and morphology. However, the patient's morphological processing was not uniformly preserved. MC performed well only the tasks that specifically required access to LS, whereas her success rate in processing morphological operations that are not sensitive to LS, such as inflectional forms which are lexically controlled, was significantly lower. She was provided with written sentences (also read aloud by the examiner) including incorrect verb forms – e.g. “*ieri Mario ha **corruto** nel parco*” (**corruto** instead of **corso**, Past Participle of *correre* “to run”) “yesterday Mario has run in the park”, “*lo scorso anno **mettei** su tre chili in un mese* (**mettei** instead of **misi**, Past Tense of *mettere* “to put”) “last year, I put on three kilos in a month”, “*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*, *misi* vs *mettei* refer to inflectional forms that are independent of LS. In this task, MC's percentage of errors was up to 40%, in the face of 100% correct responses in the morphosyntactic tasks requiring access to LS.

One could again suppose that the patient's performance in the morphosyntactic tasks 1–5 (Table 1) relies on her possibly preserved episodic memory. However, when provided with sentences including unusual/impossible combinations (e.g. “the tree walked...(in/for) an hour”, “the table died... (in/for) an hour”), she replicated her success rate across all the five tasks.

5 Conclusions

MC's pattern of performance revealed a clear dissociation between two components of verb meaning: RS and LS.

There is a need for further investigation into the RS/LS domain. This study provides a first answer to a question that has long baffled linguists and cognitive-neuroscientists: is the morphosyntactically relevant component of word meaning

(LS) neurally distinguishable from the referential meaning of words (RS)? Here we provided the first evidence that the distinction between RS and LS does have a neuropsychological correlate.

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