

Verb Meaning as Verb Argument Realization: evidence from brain-damaged and non brain-damaged populations

Christina Manouilidou

University of Patras, Patras, Greece

Institute of Neurophysiology, University Medical
Center, Ljubljana, Slovenia

chmanouilidou@upatras.gr

Abstract

The aim of this paper is to show the importance of Argument Realization as a crucial factor of understanding and processing verb meaning. We discuss experimental data from brain-damaged and non brain-damaged populations regarding verb processing demonstrating the significance of correct thematic role assignment.

1 Introduction

Previous research on verbs has mainly focused on the following principal areas of verb representation and processing: 1. Argument Structure, i.e. the specification of structural relations between the predicate and its arguments. 2. Thematic Roles, i.e. the interpretation of these arguments in terms of the roles they play in the event or state denoted by the predicate. 3. Representation of a verb's meaning in terms of its *internal structure*, traditionally studied in terms of conceptual primitives within a semantic template representing a verb or verb class. While previous theoretical and experimental work has shown the importance of these three domains in our understanding of verbs, what is less clear is the process by which the abstract thematic roles match with the specific structurally represented arguments, in other words the way thematic roles are realized as arguments at the sentence level. In this paper we will show the importance of argument realization (AR) in understanding and processing verb meaning, and by extension, sentence meaning.

2 Theoretical Background

There are various theories that attempted to shed light on the relationship between the abstract thematic roles and the concrete arguments of a

verb by targeting the interpretation of sentence constituents according to their syntactic position (i.e. thematic hierarchy, e.g. Fillmore, 1968; Grimshaw, 1990;), their general semantic content (i.e. proto-roles, e.g. Dowty, 1991), and their properties of animacy and definiteness (i.e. animacy hierarchy, e.g. Croft, 2003). Moreover, various specific hypotheses about the linking between thematic roles and a verb's arguments have been proposed (e.g., Perlmutter & Postal's 1984 Universal Alignment Hypothesis—UAH—and Baker's 1988 Universality of Theta Assignment Hypothesis – UTAH). While these theories provide the theoretical framework highlighting the importance of AR, the main purpose of the research presented here is to explore how argument realization affects language processing. We discuss experimental data from brain-damaged and non brain-damaged populations by looking at sentences which require *non-canonical* AR, such as in (1).

- (1) a. *The thunder frightened the boy*
(Theme before Experiencer)
- b. *The boy feared the thunder*
(no Agent)

We focus on two experiments which shed light, from different directions, on the same phenomenon, i.e. the role of AR in accessing verb meaning, and consequently sentence meaning. We predict that sentences with non-canonical AR will increase processing load, compared to other features of verb representation that could increase complexity, such as complex internal structure, thus highlighting the distinctive way verb AR contributes to language interpretation (Exp. 1). Similarly, we anticipate brain-damaged populations (i.e. Alzheimer's patients) to demonstrate difficulties dealing with sentences that require non-canonical AR (Exp. 2). Based on the

results of these two independent experiments we will support the idea that AR has a unique contribution to verb meaning interpretation and, consequently, to sentence processing.

3 Exp. 1: Evidence from on-line sentence processing in non brain-damaged populations

Sentences with non-canonical AR impose processing difficulties resulting in longer Reading Times (RTs) (Frazier & Clifton, 1996; Bornkessel et al. 2002, 2003; Bornkessel & Schlesewsky, 2006). In the experiment reported here (Manouilidou & de Almeida, under review), we attempted to contrast the roles of internal structure, argument structure and AR and investigate whether we can establish primacy relationships between them. We explored the performance of native speakers of English in four groups of verbs that differ with respect to their internal structure (change-of-state [+CS] vs. non-change-of-state verbs [-CS]) and their thematic roles which might result in non-canonical AR (Agent [+AG] vs. NonAgent [-AG]).

Participants. Thirty-eight undergraduate students participated in the study for course credit. They were all native speakers of English and had normal or corrected-to-normal vision.

Materials. 128 experimental sentences were included, divided into four conditions, according to the variables of change of state (+/-CS) and agentivity (+/-AG). These sentences formed 32 sets such as the one presented in (2). All sentences were normed for plausibility and naturalness and had the same basic syntactic structure, with a NP+Adv+VP (V+NP). We employed manner and degree adverbs in an attempt to affect the volition of the NP occupying the canonical subject position of the sentence. This manipulation was particularly important in conditions such as 2b ([+CS, -AG]), which could denote an intentional act on the part of the Causer of the fright state. Adverbs were also used to further enforce an agentive reading in conditions such as 2a ([+CS, +AG]), and 2c ([-CS, +AG], as well as to keep constant structure and length for all sentence types.

(2)

- a. The hunter maliciously *killed* the bear (+CS,+AG, lexical causatives)
- b. The hunter unintentionally *frightened* the bear (+CS, -AG, object-experiencer)
- c. The hunter persistently *followed* the bear (-CS, +AG, agentive transitive)

- d. The hunter barely *sensed* the bear (-CS, -AG, subject-experiencer)

Procedure. We employed a self-paced reading moving window paradigm. Participants were first presented with a row of dashes on the screen. Each dash represented a letter in the to-appear sentence (such as “--- ----- ----- ----- -----” for sentence (2a)). They were told that each time they pressed the space bar on the computer keyboard, a word would appear in place of the dashes and, as each new word appeared, the previously presented word would turn back to a set of dashes.

Results. RTs for each of the three words of the VP (Verb, Determiner, and Noun) for the four sentence types (lexical causatives, object-experiencer, agentive transitive, and subject-experiencer) constituted the raw data for analyses. Figure 1 depicts the reading times at the **verb** position for the four conditions. A 2 (verb type: +CS vs. -CS) x 2 (agency: +AG vs. -AG) x 3 (VP segment: Verb, Det, Noun) repeated-measures ANOVA showed **no effect of verb type**, $F(1, 37) = .25, p = .62$, a marginal **effect of agency**, $F(1, 37) = 3.52, p = .069$ and a **significant effect of segment**, $F(2, 74) = 20.73, p < .0001$. There was also a significant **interaction between verb type and segment**, $F(2, 74) = 3.35, p = .041$. In order to understand how different verb types behaved with regards to different agency manipulations, we performed planned comparisons between the four conditions.. For the **analysis of [-CS] verbs** (*love, follow*), there was no effect of agency, $F(1, 37) = .36, p = .55$, while the analysis of [+CS] verbs (*kill, frighten*), showed a significant effect of agency, $F(1, 37) = 6.17, p = .02$. In the analysis of the two agentive sentence types [+AG], a repeated-measures ANOVA showed again no main effect of verb type, $F(1, 37) = .113, p = .74$, suggesting that [+CS] and [-CS] structures behave similarly when they are both agentive. Finally, in the analysis of the **two non-canonical structures, [-AG]**, the object-experiencer (+CS, -AG) (*frighten*) and subject-experiencer (-CS, -AG) (*love*), a 2 (verb type: [+CS, -AG] vs. [-CS, -AG]) x 3 (VP segment) repeated-measures ANOVA showed no main effect of verb type, $F(1, 37) = .56, p = .46$, but a significant effect of segment, $F(2, 74) = 19.55, p < .0001$, and a significant interaction between verb and segment, $F(2, 74) = 4.05, p = .014$. In pairwise analyses, we found a significant difference be-

tween the two constructions at the verb position, $t(37) = 2.86, p = .007$, with [+CS] taking longer than [-CS]. There was no difference between the two [+AG] sentences at the verb locus.¹ In sum, Exp. 1 showed an effect of [CS] only for the [-AG] structures, but not in the [+AG] structures. This suggests that CS *per se* does not account for increased RTs. With respect to non-canonical AR, results showed that there is an effect of agency in [+CS] structures which is only marginal in the [-CS] structures, with [-AG] structures being more difficult to process. Thus, the results suggest that atypical AR, in terms of absence of typical Agent, increases sentence complexity and yields longer RTs in verbal position. In contrast, internal structure does not seem to have an effect in sentence processing. The current findings seem to be in accordance with previous studies indicating a *thematic reanalysis* in sentence processing, which appears to have a processing cost, when the processor's expectations of a thematic role in a particular structural position are not met (see Bornkessel and colleagues). Looking at this outcome in the bigger picture, the present study has shown how *structural and thematic* properties of a verb play the primary roles in sentence comprehension, thus reflecting their prominent role in verb representation.

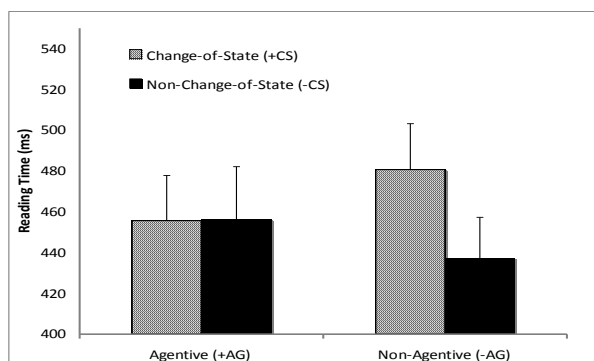


Figure 1: Reading times (in milliseconds) at the verb position in the four sentence conditions.

¹ Paired t-tests showed no significant difference between the mean length of the adverbs used in each condition ([+CS vs -CS]: $p=.20$; [+AG vs -AG]: $p = .12$) neither between their mean frequency ([+CS vs -CS]: $p=.15$; +AG vs -AG]: $p = .20$). Besides, a post-hoc analysis on adverb RTs showed no significant difference among them. Thus, a possible influence of the adverb length and adverb frequency on the verb RTs should be ruled out.

4 Exp. 2: Evidence from off-line sentence processing in brain-damaged populations²

Language impairment studies examining the correspondence between thematic roles and syntactic properties highlight the importance of AR (e.g.; Pinango, 2006). The notion of canonicity in verb-argument relations has been reported to influence sentence processing in aphasic patients (Caplan & Hildebrandt, 1988), and in dementia (Kemper, 1997; Kemper et al., 1993; Lyons et al., 1994; Small, Andersen, et al., 1997; Small, Kemper, et al., 1997; Small et al., 2000). However, in these studies, canonicity in verb-argument relations is usually described in terms of non-canonical thematic role assignment as a result of syntactic manipulations, such as in passive sentences. Hence, non-canonical thematic role assignment and its processing cost cannot be dissociated from other factors that affect sentence processing, such as syntactic movement. For this reason, we cannot be certain that the observed difficulties arise exclusively from non-canonical AR. It could be the case that patients' difficulties are associated with memory and cognitive resources something that Small et al. (2000) also point out. In the sentence completion task described below (Manouilidou et al., 2009) we examined the question of non-canonical thematic role assignment in the performance of populations suffering from dementia in terms of verb-specific requirements and not as a side effect of syntactic manipulations.

Participants. 10 individuals with the diagnosis of probable Alzheimer's Disease (pAD) (mean age: 75.8; s.d. 5.99), 11 elderly controls (mean age 87.25; s.d. 2.5) and 49 young controls (age range: 18-25). The pAD patients' Mini Mental State Examination (MMSE; Folstein, Folstein, and McHugh, 1975) scores ranged from 19 to 27 indicating mild to moderate cognitive impairment. They were all native speakers of English with a minimum education level of sixth grade.

Materials. Patients were required to complete 72 active and passive written sentences by choosing the correct verb. Materials were divided into 6

² This section is based on Manouilidou et al. (2009). Thematic Hierarchy violations in Alzheimer's disease: the case of psychological verbs. *Journal of Neurolinguistics* Vol. 22, pp.167-186.

conditions, with 12 sentences in each of them: (1) subject-experiencer verbs (e.g., *fear*); (2) object-experiencer verbs (e.g., *frighten*); (3) subject-agent verbs (e.g., *kick*); and (4), (5) and (6) were the passive equivalent of (1) (2) and (3), respectively (e.g., *was feared*, *was frightened* and *was killed*).

Design and Procedure. Participants were presented with the sentences with the verb missing marked by a blank line (e.g., *The boy_____the thunder*). They had to choose the correct verb from a list of four verbs, which included the target (e.g., *fear*) its “thematic” distractor³ (e.g., *frighten*), a syntactically anomalous distractor (e.g., *sleep*) and a semantically unrelated distractor (e.g., *cook*). Materials were divided into four blocks. For sentences corresponding to the *fear-frighten* minimal pairs, four versions were created (e.g., *The boy feared the thunder*, *The thunder frightened the boy*, *The boy was frightened by the thunder*, and *The thunder was feared by the boy*), with one version in each block. Active and passive versions of the agentive verbs complemented the blocks (e.g., *the hunter killed the deer*, *the deer was killed*). Patients and elderly controls saw all four blocks, with two blocks in each of the two sessions, one week apart. Sentences were presented on a computer screen and participants had to choose the correct verb by pressing a key on the keyboard. Each verb on the screen lead to a specific key by an arrow to facilitate the choice by the patients. Testing was completed in two sessions one week apart.

Results. Percentages of correct responses were calculated for each condition (Figure 2). A 3 (group: patients vs. elderly controls vs. young controls) x 3 (voice: active vs. passive) x 2 (subject thematic role: subject-experiencer, object-experiencer, subject-agent) repeated-measures ANOVA⁴ showed that patients’ data differed significantly from those of the elderly ($p < .0001$) and the young controls ($p < .0001$); also, a main effect of verb type was obtained ($p = .013$), but

³ In case of agentive verbs, the reverse distractor was a verb in the same semantic field but with different thematic roles. For instance, the distractor for *kill* was *die*.

⁴ In all cases, arcsine transformation was employed. However, since we obtained the same effects as with raw data, we choose to report the analyses on the untransformed data.

not of voice (active vs. passive) ($p = .13$). Repeated measures ANOVAs on the patient data showed a main effect of verb type ($p < .001$) and a tendency for a main effect of voice ($p = .067$). Error analysis showed that patients chose the reverse distractor more times when confronted with a psych verb than when confronted with an agent verb. They seldom chose the unrelated distractors. Thus, for example, when confronted with a sentence frame such as *The thunder_____the boy* patients selected the correct response *frightened* only 58% of the time—confusing it with *fear* the other times. Most interestingly, there was also a difference between (1) (subject-experiencer) and (2) (object-experiencer) in the active voice ($p = .02$) but no difference between their passive equivalents ($p = .46$).

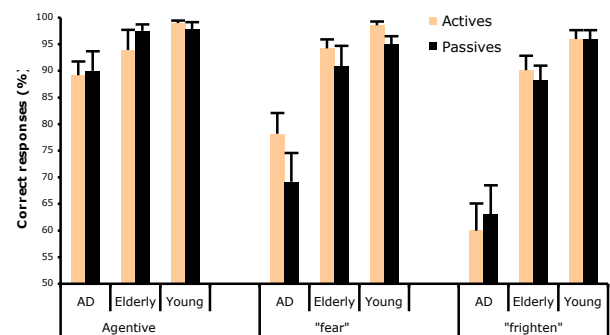


Figure 2: Mean percentage correct responses for the three groups in all conditions. Error bars indicate standard errors.

In sum, the results of Exp. 2 are consistent with our predictions, showing that patients had difficulties completing sentences that required non-canonical argument realization. More importantly, the present study allowed us to identify as source of this difficulty patients’ inability to assign the correct thematic roles to the NPs (patients did have access to the correct core meaning of the verb since they almost never chose the unrelated distractors). We take this result to consist additional evidence for the importance of AR in accessing verb and consequently, sentence meaning.

5 Conclusion

The experiments described above come to add to the body of previous research showing the processing costs of non-canonical AR and by extension the general role of AR in sentence processing and verb meaning. Both studies highlight the

importance of the [+agentive] feature in verb representation, which projects a canonical argument realization, as a decisive factor in thematic role assignment. The absence of the Agent argument creates difficulties in thematic role assignment, either resulting in thematic reanalysis, and thus, increased processing times (Exp. 1), or in the creation of implausible sentences in neurologically damaged populations (Exp. 2).

REFERENCES

- Baker, Mark. 1988. *Incorporation: a theory of grammatical function changing*. University of Chicago Press.
- Bornkessel, Ina, Matthias Schlesewsky & Angela D. Friederici. 2002. Beyond syntax: Language-related positivities reflect the revision of hierarchies. *Neuroreport* 13. 361–364.
- Bornkessel, Ina, Matthias Schlesewsky & Angela D. Friederici. 2003. Eliciting thematic reanalysis effects: The role of syntax-independent information during parsing. *Language and Cognitive Processes* 18. 268–298.
- Bornkessel, Ina & Matthias Schlesewsky. 2006. The extended argument dependency model: a neurocognitive approach to sentence comprehension. *Psychological Review* 113(4): 787–821.
- Caplan, David & Nancy Hildebrandt. 1988. *Disorders of syntactic comprehension*. Cambridge, MA: MIT Press.
- Croft, William. 2003. *Typology and universals, second edition*. (Cambridge Textbooks in Linguistics.) Cambridge: Cambridge University Press.
- Dowty, David. 1991. Thematic proto-roles and argument selection. *Language* 67. 547–619.
- Fillmore, Charles J. 1968. Lexical entries for verbs. *Foundations of Language* 4(4). 373–393.
- Frazier, Lynn & Charles Clifton. 1996. *Construal*. Cambridge, MA: MIT Press.
- Grimshaw, Jane. 1990. Argument Structure. [Special issue]. *Linguistic Inquiry* 18.
- Kemper, Susan. 1997. Metalinguistic judgments in normal aging and Alzheimer's disease. *Journal of Gerontology: Psychological Sciences*, 52B(3), 147–155.
- Kemper, Susan, Emily LaBarge, Richard F. Ferraro, Hintat Cheung, Him Cheung & Martha Storandt. 1993. On the preservation of syntax in Alzheimer's disease: evidence from written sentences. *Archives of Neurology*, 50, 81–86.
- Lyons, Kelly, Susan Kemper, Emily LaBarge, Richard F. Ferraro, David Balota & Martha Storandt. 1994. Oral language and Alzheimer's disease: a reduction in syntactic complexity. *Aging and Cognition*, 1, 271–281.
- Manouilidou, Christina. & Roberto G. de Almeida, (under review). On the Psychological Reality of Verb Typologies: contrasting the roles of internal structure and argument realization.
- Manouilidou, Christina, Roberto G. de Almeida, George Schwartz & N.P. Vasavan Nair. 2009. Thematic Hierarchy violations in Alzheimer's disease: the case of psychological verbs. *Journal of Neurolinguistics* Vol. 22, pp.167–186.
- Pinango, Maria Mercedes. 2006. Thematic roles as event structure relations. In I. Bornkessel, M. Schlesewsky, & A. Friederici (Eds.), *Semantic role universals and argument linking: Theoretical, typological, and psycholinguistic perspectives*. Berlin: Mouton.
- Perlmutter, M. David & Paul M. Postal. 1984. The 1-Advancement Exclusiveness Law? in D.M. Perlmutter and C. Rosen, eds., (1984) *Studies in Relational Grammar 2*, University of Chicago Press, Chicago, IL, 81–125.
- Small, A. Jeff, Elaine S. Andersen, & Daniel Kempler. 1997. Effects of working memory capacity on understanding rate-altered speech. *Aging, Neuropsychology, and Cognition*, 4(2), 126–139.
- Small, A. Jeff, Susan Kemper & Kelly Lyons. 1997. Sentence comprehension in Alzheimer's disease: effects of grammatical complexity, speech rate and repetition. *Psychology and Aging*, 12(1), 3–11.
- Small, A. Jeff, Susan Kemper & Kelly Lyons. 2000. Sentence repetition and processing resources in Alzheimer's disease. *Brain and Language*, 75, 232–258.