UC Merced

Proceedings of the Annual Meeting of the Cognitive Science Society

Title
A Connectionist Account of the Pattern of Deficits Across Semantic and Lexical Tasks in Five Semantic Dementia Patients

Permalink
https://escholarship.org/uc/item/59r5f211

Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 28(28)

ISSN
1069-7977

Authors
Dilkina, Katia
McClelland, James L.

Publication Date
2006

Peer reviewed

A Connectionist Account of the Pattern of Deficits
Across Semantic and Lexical Tasks in Five Semantic Dementia Patients

Katia Dilkina (knd@andrew.cmu.edu)
Psychology Department and Center for the Neural Basis of Cognition, Carnegie Mellon University
5000 Forbes Ave, Pittsburgh, PA 15213 USA

James L. McClelland (jlm@cnbc.cmu.edu)
Psychology Department and Center for the Neural Basis of Cognition, Carnegie Mellon University
5000 Forbes Ave, Pittsburgh, PA 15213 USA

Semantic dementia (SD) is a selective impairment to the semantic system due to progressive atrophy of the frontal and the temporal cortices. The temporal atrophy starts from the pole and progresses posteriorly. Tasks that are usually impaired in SD patients include object/picture naming, word-picture matching, and delayed copying. In addition to the semantic impairment, SD patients also show compromised performance on a number of lexical tasks such as word reading, spelling, verb past-tense inflection, and two-alternative forced choice lexical decision. Similarly to the semantic deficits, the lexical deficits are most prominent for atypical low-frequency items.

For the majority of the patients, performance measures on the tasks mentioned above correlate with each other and with the overall semantic performance (cf. Patterson et al., 2005). These findings have motivated the idea that lexical and semantic deficits arise as consequences of damage to a single integrated system that mediates both semantic and lexical processing.

Notably, however, the correlations of performance on the different tasks form a wide distribution. Furthermore, individual case studies have been reported of patients who fail to show a correlation between reading, in particular, and tasks such as naming and word-picture matching (e.g., Blazely et al., 2005; Cipolotti & Warrington, 1995). Such cases present a challenge to the single system view. Our purpose is to explore whether this challenge can be addressed.

The aim of the current study was to shed more light on the mechanisms by which tasks such as reading and naming are performed and the reasons why performance on these tasks may be partially but not perfectly correlated across patients. We believe that the robustness of semantic and lexical knowledge may depend on a number of factors, so that the observed differences in performance in SD patients might arise from differences in experience, differences in the proficiency of the direct pathway mapping orthography to phonology, and/or differences in the spatial distribution of the brain atrophy.

Method & Results
The hypothesis was tested with a neural network simulation that included four input/output layers – visual (V), motor (M), orthographic (O), and phonological (P) (figure 1).

There was full bidirectional connectivity between all input layers and semantics, and full recurrence within the semantic layer. There was also a direct pathway between O and P, which was also fully recurrent.

The network was trained given a V or an O pattern as input to produce either all four corresponding outputs or only P output. Then, it was damaged by lesioning semantic units as well as links between semantics and V, M, O, and P. Testing included naming (producing the correct P pattern to a given V input) and reading (producing the correct P pattern to a given O input).

We modeled the naming and reading data from five SD patients (GC, JL, and FM reported by Graham et al., 1994; EM and PC reported by Blazely et al., 2005). Three aspects of the network were manipulated to model individual differences: (1) training regime (ratio of V to O input = 1:1 vs. 1:2); (2) direct pathway size (10, 20 or 30 units); and (3) lesion distribution (damage of the connections between semantics and the four visible layers in equal ratio vs. biased toward V vs. biased toward O). The patients' performance broken down by frequency and regularity fit within the 95% confidence interval of the simulation results. **Patient GC**: Simulated by a central lesion in a network with a 10-unit direct pathway and 1:1 training regime. **Patients PC & JL**: Simulated by central lesions in a network with a 20-unit direct pathway and 1:1 training regime. **Patients EM & FM**: Simulated by visually-biased lesions in a network with a 20-unit direct pathway and 1:2 training regime.

References

Blazely, A., Coltheart, M., & Casey, B. J. (2005). Semantic impairment with and without surface dyslexia: Implications for models of reading, *Cognitive Neuropsychology*, *22*, 695-717.

Cipolotti, L., & Warrington, E. K. (1995). Semantic memory and reading abilities: A case report, *Journal of the International Neuropsychological Society*, *1*, 104-110.

Graham, K. S., Hodges, J. R., & Patterson, K. (1994). The relationship between comprehension and oral reading in progressive fluent aphasia, *Neuropsychologia*, *32*, 299-316.

Patterson, K., Lambon Ralph, M.A., Jefferies, E., Woollams, A., Jones, R., Hodges, J.R., & Rogers, T.T. (2005). 'Pre-semantic' cognition in semantic dementia: Six deficits in search of an explanation, *Journal of Cognitive Neuroscience*, *18*, 169-183.