ARE JUDGEMENTS OF SEMANTIC SIMILARITY ACROSS DIFFERENT ANIMAL CATEGORIES SYSTEMATICALLY DISRUPTED IN ALZHEIMER'S DISEASE?

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Introduction

Recent studies have used multidimensional scaling (MDS) techniques to investigate judgements of semantic relatedness in patients with AD (e.g. Chan et al. 1995 & 1997). However, these have been criticized on two counts:

i) The stimuli in these experiments differed only along fairly fine-grained semantic boundaries, known to be most vulnerable to semantic impairment. Such materials may not be sensitive to the systematic preservation of more general semantic knowledge in AD (Rogers, 2003)

ii) The MDS technique employed in these studies might not not be suitable to measure semantic impairments (Storms et al., 2003)

Aims

- Are AD patients differentially affected in their semantic judgements if the stimulus set is chosen according to broad vs. fine-grained distinctions?
- Is the Multidimensional Scaling (MDS) technique an appropriate tool to measure semantic deficits in AD patients?

Subjects

16 Controls; 8 AD patients (average age = 65.2 years, s.d.= 5)

Neuropsychology:

Patients had an average MMSE of 21.4, poor episodic memory (LM delayed recall .03) and mild semantic impairment (GNT 15.6)

Design

At test, animal names were varied along a broad (Land/Water) and more fine-grained (Bird/Non-bird) dimension:

	Bird	Nonbird
Land	Woodpecker Magpie Pheasant	Badger Squirrel Hedgehog
Water	Penguin Duck Swan	Turtle Frog Crocodile

Triadic comparison task = similarity judgement: 'Which two of these three animals go or fit best together?'

magpie
woodpecker turtle

crocodile
magpie penguin

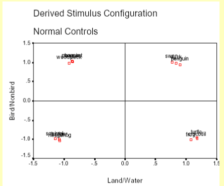
MDS Analysis

Stimuli proximities were calculated for each subject by counting the number of times that every stimulus pair was chosen as the most similar pair in a triad.

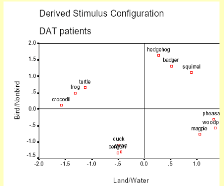
Application of the ALSCAL algorithm produced 2D group plots showing how, on average, the patients and controls tended to group test items. Stress values indicate 'goodness-of-fit' for the group data, with lower scores indicating a better fit.

MDS group results

– Both groups were clearly sensitive to the two semantic dimensions.
– But stress values were lower for the normal controls than the patients, indicating a better group fit (p <.001).



Control Stress: .182

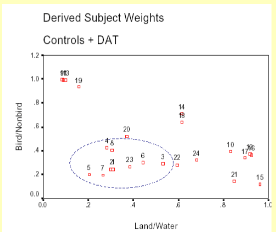


AD patients stress: .353

MDS individual results

– The ALSCAL algorithm also provides individual subject weights, which indicate how strongly each person weights the two dimensions from the group solution when making his/her similarity judgements.

Group: p < .001
Cat.: n.s.
Group x Cat.: n.s.



– Patients received lower weightings on both dimensions relative to controls, indicating less sensitivity to both semantic distinctions (p < 0.001).
– But controls also varied widely in their sensitivity to the two dimensions!
– Does this confirm that patients are equally impaired in both broad and fine grained category distinctions?
…or is the MDS method itself not valid for the data?
– More specifically, it is not obvious from the MDS analysis for which category the patients make more errors, and hence are impaired.

Accuracy Analysis

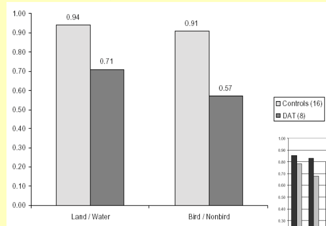
Would an accuracy analysis be more conclusive in assessing how sensitive AD patients are to the different dimensions categories? To assess this, trials were classified as:

Convergent: Only Land/Water or Bird/Nonbird correct (e.g. magpie, woodpecker, turtle)
Divergent: Either Land/Water or Bird/Nonbird correct (e.g. penguin, magpie, crocodile)
Random: Neither Land/Water or Bird/Nonbird correct (e.g. badger, squirrel, hedgehog)

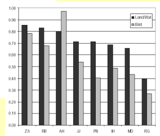
Accuracy Results

Convergent Trials:

- AD Patients are impaired in the similarity judgement for both dimensions in comparison to Controls.
- However 7 of 8 patients were worse for bird/nonbird trials than land/water trials (p < 0.04 from binomial distribution).



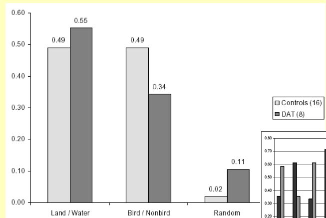
Group: p < .000
Cat.: p < .025
Group x Cat.: n.s. (p = .136)



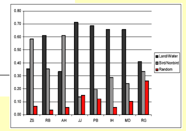
AD patients only

Divergent Trials:

- AD patients are impaired in the similarity judgement only in the Bird/Nonbird category, though this remains statistically n.s.!



Group: n.s.
Cat.: p < .001;
Group x Cat.: n.s.



AD patients only

Accuracy Results

- Considering the data from patients with AD:
  - for the convergent trials: only one out of eight patients was more accurate in the Bird/Non-bird than the Land/Water dimension.
  - for the divergent trials: only two out of eight patients have a preference for the Bird/Non-bird category
- Although the Group x Cat interaction was not significant in the AOV for either trial type, all but one of the patients did better for land/water than bird/nonbird trials in the convergent set -- a result that is unlikely to have occurred by chance (p < 0.04). If the anomolous patient is excluded, the interaction is reliable for convergent trials (p < .05).

Discussion

Healthy Controls:

Normal controls showed equivalent high sensitivity to both dimensions. On divergent trials where the two dimensions conflicted, control subjects split their judgements equally! One half consistently preferred the Land/Water distinction, the other half the Bird/Non-bird distinction.

AD patients:

AD patients were less consistent overall in their application of both dimensions(p < .001). On divergent trials, while patients were as sensitive as controls to the Land/Water distinction, they were less sensitive to the Bird/Non-bird distinction and more likely to make seemingly arbitrary/ idiosyncratic choices in these cases.

Conclusion

The data suggest that the Bird/Non-bird distinction may be more vulnerable to AD than the Land/Water distinction, despite being equally salient to healthy controls. Hence, semantic similarity judgements appear to be disrupted systematically in AD.

As proposed by Storms et al. (2003), our data show that the MDS analysis might be inconclusive or even misleading when used to investigate semantic similarity judgements and that a 'standard' accuracy analysis may be more informative.

References

- Chan et al; Neuropsychologia, 1997 35(3); 241- 248
- Storms et al., Neuropsychology, 2003 17(2), 289-301
- Rogers, Neuropsychology, 2003 17(2), 318-320