

# Colour knowledge in semantic dementia: It's not all black and white

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## INTRODUCTION

Patients with semantic dementia (SD) exhibit a progressive and profound deterioration of conceptual knowledge, with remarkable sparing of other aspects of cognitive function. The semantic impairment in SD affects knowledge of object properties in different modalities, including names, visual structure, characteristic sounds, and associated actions. However, a recent study by Robinson and Cipolotti (2001) suggests that knowledge about colours may be spared in the disorder. Here we report a case series investigation of colour knowledge in semantic dementia, to determine whether such knowledge is generally less vulnerable to semantic impairment than other kinds of conceptual knowledge.

## Experiment 1: Colouring line drawings

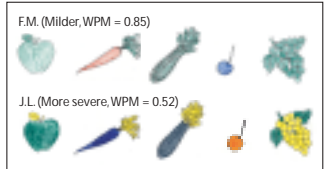
- 15 patients with semantic dementia (SD) were asked to colour 40 line drawings of common objects.
- Drawings included fruits and vegetables, land animals, body parts, and artifacts with conventional colours (e.g. traffic lights).
- First 2 participants coloured all drawings; remaining 13 just pointed to the crayons they would use.
- Results were compared to choices of age-matched controls.

## Examples of coloured drawings

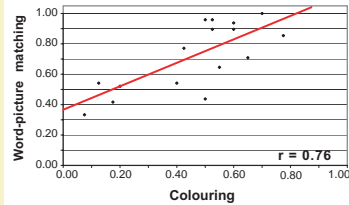
### Animals



### Fruits and vegetables.

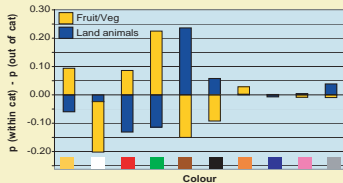


## Correlation of colouring with semantic impairment



■ Colouring correlates strongly with word-picture matching.

## Likelihood of applying colour to plants and animals



- Figure shows the likelihood of choosing a given colour for items within a category (plant or animal), minus the likelihood of choosing the colour for other items.
- Participants choose different colours for items in different semantic categories
- They strongly prefer green for plants but not animals, and brown for animals but not plants.

## Conclusions from experiment 1

- Knowledge about the colours of objects is compromised in SD, to a degree commensurate with overall semantic impairment.
- Colouring choices reflect the continuing robustness of broad semantic distinctions, such as the animate/inanimate distinction.
- Patients with SD show some tendency to extend the colours typical of a given domain to inappropriate domain exemplars; for example, choosing "green" for many non-green fruits, and "brown" for many non-brown animals.
- These results are consistent with the general pattern of deterioration observed for other kinds of semantic knowledge.

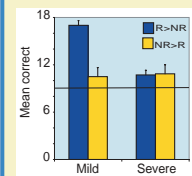
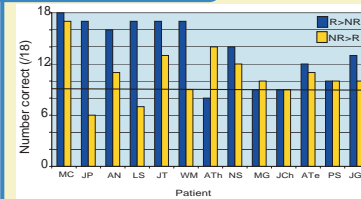
## Experiment 2: The Over-regular Colour Test (OCT)



Which ones are real?

- Participants are shown line drawings of common objects side-by-side, identical except for colour, and are asked to decide which is coloured correctly.
- 1/3 are fruits or vegetables, 1/3 are animals, and 1/3 are filler items with conventional colourings.
- For R>NR items, the target has a colour typical of its domain, and the distractor has a different colour
- For NR>R items, the distractor has a colour typical of its domain, and the target has a different colour

## Results for 13 patients with SD



- Milder patients show a strong effect of regularity, performing at ceiling in the R>NR condition and at chance in the opposite condition.
- More severe patients are at chance in both conditions.

## Conclusions from Experiment 2

- As has been demonstrated previously for object and word recognition, patients come to rely on knowledge about domain-typical properties when making colour-recognition judgments under semantic impairment.
- However, colour knowledge appears to be considerably more vulnerable to semantic impairment than is structural knowledge about objects or words.

## Experiment 3: Testing colour concepts

What accounts for the surprising vulnerability of knowledge about the colours of objects? One possibility is that colour concepts are themselves vulnerable to the semantic impairment observed in SD. To investigate this possibility in Experiment 3, we tested the ability of patients with SD to name, discriminate, and categorise colours.

## Colour naming

Can you name these colours?



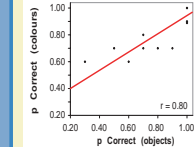
- 12 SD patients were asked to name the colours of 10 crayons as depicted here.

- 10 patients were also asked to name 10 line drawings, matched to the colour names for word, lemma, and surface form frequency.

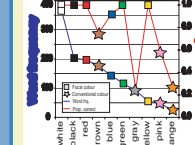
- Performance on the colour- and object-naming tasks was strongly correlated. No patient was reliably better on colour than object naming.

- Patients made remarkably consistent errors: all performed at ceiling for focal colours, regardless of word frequency; but showed a frequency-weighted impairment for colours defined solely by language convention.

## Correlation w/ object naming

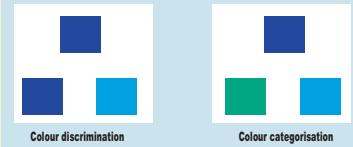


## Accuracy for each colour

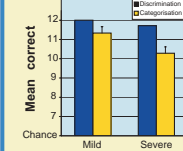


## Colour matching

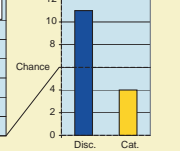
Which of the two on the bottom is the same as the one on the top?



## 13 SD cases



## J.W.



## Conclusions from Experiment 3

- When word frequencies are matched, colour and object naming are equally impaired in semantic dementia. Atypical or conventional colour names are more vulnerable than typical or focal colours.
- The ability to discriminate subtly different colours is unaffected by the disease.
- However, the ability to group different hues into the same colour category, as required by the matching task shown above, may be compromised by semantic impairment.

## General conclusions

Knowledge about the colours of objects, like all object properties examined to date, is vulnerable to semantic impairment. Domain-typical colours are over-extended to inappropriate domain exemplars, just as are domain-typical structural properties in drawing and object decision, and domain-typical labels in confrontation naming. Colour knowledge, if anything, appears to be even more vulnerable to semantic impairment than other properties. This may reflect the fact that colour concepts themselves degrade with semantic impairment, as suggested by our study of colour naming and categorisation.