Cognitive Neuroscience of Language: 10: Deep dyslexia

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Goals

Understand the characteristics of the deep dyslexic syndrome

Understand the theoretical approaches to the syndrome

Scan data from deep dyslexia

Coltheart et al. (1980)
Data from deep dyslexia

Marshall & Newcombe (1973)

Semantic errors ("chair" for "table")
Nonword errors ("sweets" for "teep")
Visual errors ("justice" for "just")
Visual and semantic errors, more than expected by chance ("skirt" for "shirt")
Morphological errors ("loving" for "lovely")
Function word errors ("in" for "his")
Abstract word errors ("don't know" for "chance")
Abstract

→ concrete ("flan" for "plan")

Mixed errors ("sympathy" for "orchestra")

Category specific errors ("don’t know" for "lemon, pineapple,...")

Impaired rhyme judgements

No effect of regularity manipulation

Often surprisingly good lexical decision

Reading aloud:

nouns > adjectives > verbs > function words

Often Broca’s aphasia, right hemiplegia

Marshall & Newcombe (1973)
Data from deep dyslexia

Marshall & Newcombe (1973)

Impaired writing, with semantic errors in spelling

Impaired auditory-verbal short-term memory

Reading words may depend completely on their sentence context

The individual’s confidence in particular types of error may vary
“Classical” view of deep dyslexia


... plus a comprehension/production dissociation, syntactic problems for morphology, ...

Print

Letter identification

Orthographic input lexicon (PINT)

Spelling-sound correspondences

Phonological output lexicon (pamt)

Phoneme system

Speech

Semantic system
A model should have an emergent aspect to it; it should be more than a description of the data.

There are no patients with subsets of the symptoms.

Deep dyslexic reading looks like RH language, as seen in commissurotomy patients (Michel et al., 1996), lateralized presentation studies, and left hemispherectomy patients (Patterson et al., 1987).

Orthographic and semantic processing in deep dyslexia reflect RH reading.
Connectionist computational modelling of deep dyslexia

Hinton, Plaut, Shallice (1993)

Connectionist models are good at learning quasi-regular mappings, such as orthography → phonology
Connectionist computational modelling of deep dyslexia

Hinton, Plaut, Shallice (1993)

But any relationship with semantic representations is largely *arbitrary*. Recurrent connections can “clean up” outputs
The model is trained so that the pattern of activation over its output units settles into the desired steady states (Plaut & McClelland, 1993)
Attractors and basins of attraction

Bidirectional excitation caused network to settle into a particular stable state over time: the attractor.
Modelling deep dyslexia

Plaut & Shallice, 1993
Effects of lesioning on attractors

After training

When lesioned

Lesioning a network, by removing some proportion of its units or connections, alters the settling behaviour of the remaining units. In state space, the effects of damage amount to distortions of the shapes and positions of attractors basins.
The model produces the mix of core errors.

Depending on where the model is lesioned, it produces biases in the mix of errors.

The lexicon is small, and the category specific behaviour relies on modelling choices regarding the number of semantic features.
Modelling deep dyslexia
Jeffries et al. (2007)

There is a case that impaired primary systems such as semantics and vision, but particularly phonology, can give rise to “deep” symptoms.

This can be offset if there is a good input and strong systematicity between input and output.
Other orthographies


<table>
<thead>
<tr>
<th>Regular character</th>
<th>Irregular character</th>
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<tbody>
<tr>
<td>評</td>
<td>秤</td>
</tr>
<tr>
<td>Pronunciation: [Píng]</td>
<td>Pronunciation: [Chèng]</td>
</tr>
<tr>
<td>Meaning: comment</td>
<td>Meaning: steelyard</td>
</tr>
</tbody>
</table>

**Phonetic radical**

| 平 |
| Pronunciation: [Píng] |

**Regularization**

秤 [Chèng] --- pronounced as [Píng]
de Partz (1986) reports retraining of a fluent deep dyslexic to a slow reading ability

Residual letter recognition was used ("c" recognized as "Carole"), and these were associated with the first segment of the word.

The grapheme-phoneme rules (of French) were explicitly taught.

N.B. The patient was initially fluent. The retraining was very laborious.
Conclusions

The various symptoms of deep dyslexia hang together coherently in a syndrome.

A connectionist model can simulate this coherence; in part, the behaviour emerges from the nature of the problem.

At one level, deep dyslexic reading resembles RH language capacities.

These two explanations are not mutually exclusive.