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

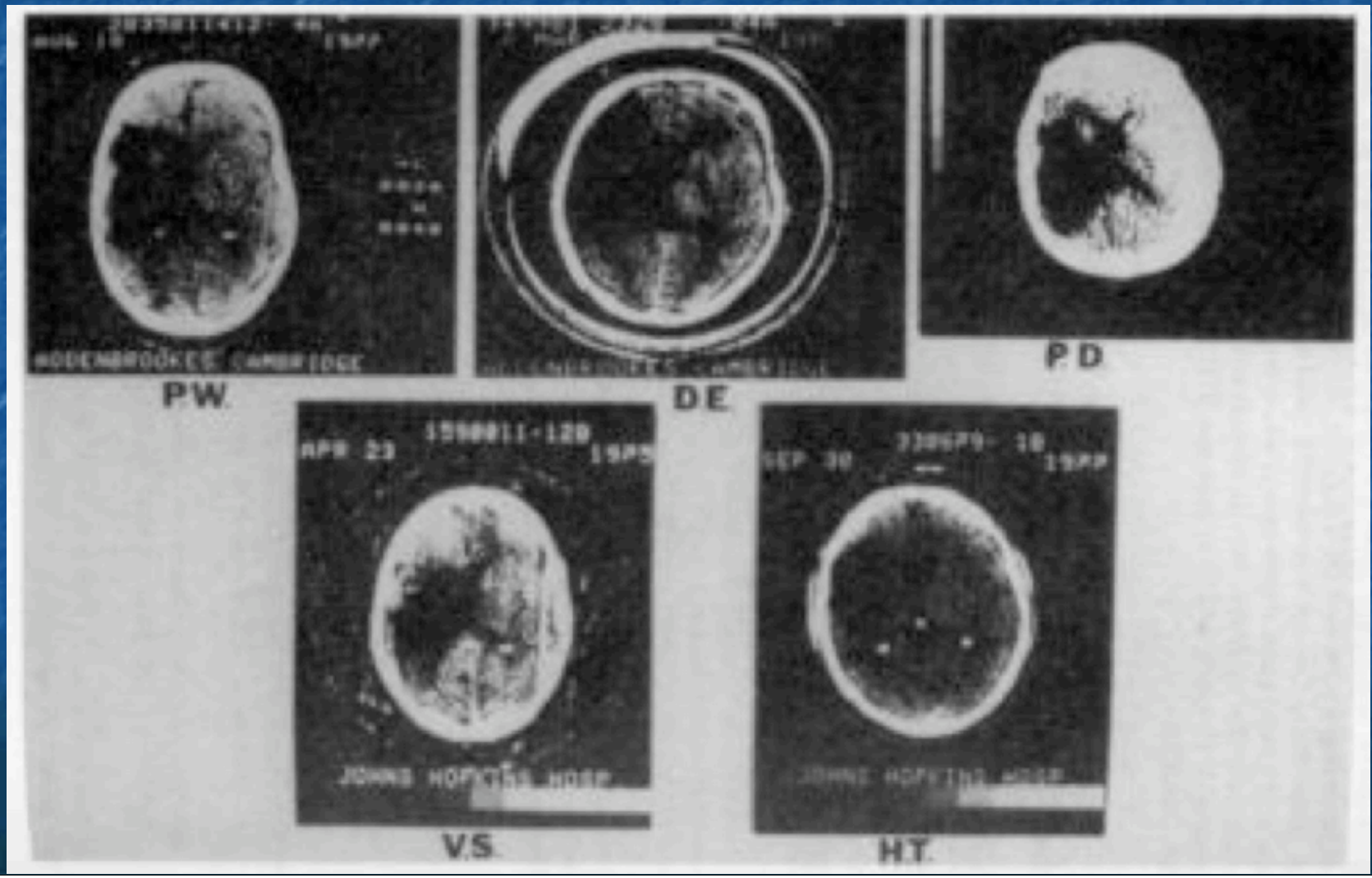
Reading

Coltheart *et al.* (2000). Deep dyslexia is Right-Hemisphere Reading. *Brain & Language*, 71, 299-309.

Plaut, D.C. & Shallice, T. (1993). Deep Dyslexia: A Case Study of Connectionist Neuropsychology. *Cognitive Neuropsychology, 10*, 377–500.

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")

Data from deep dyslexia

Marshall & Newcombe (1973)

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

Data from deep dyslexia

Marshall & Newcombe (1973)

Impaired writing, with semantic errors in spelling

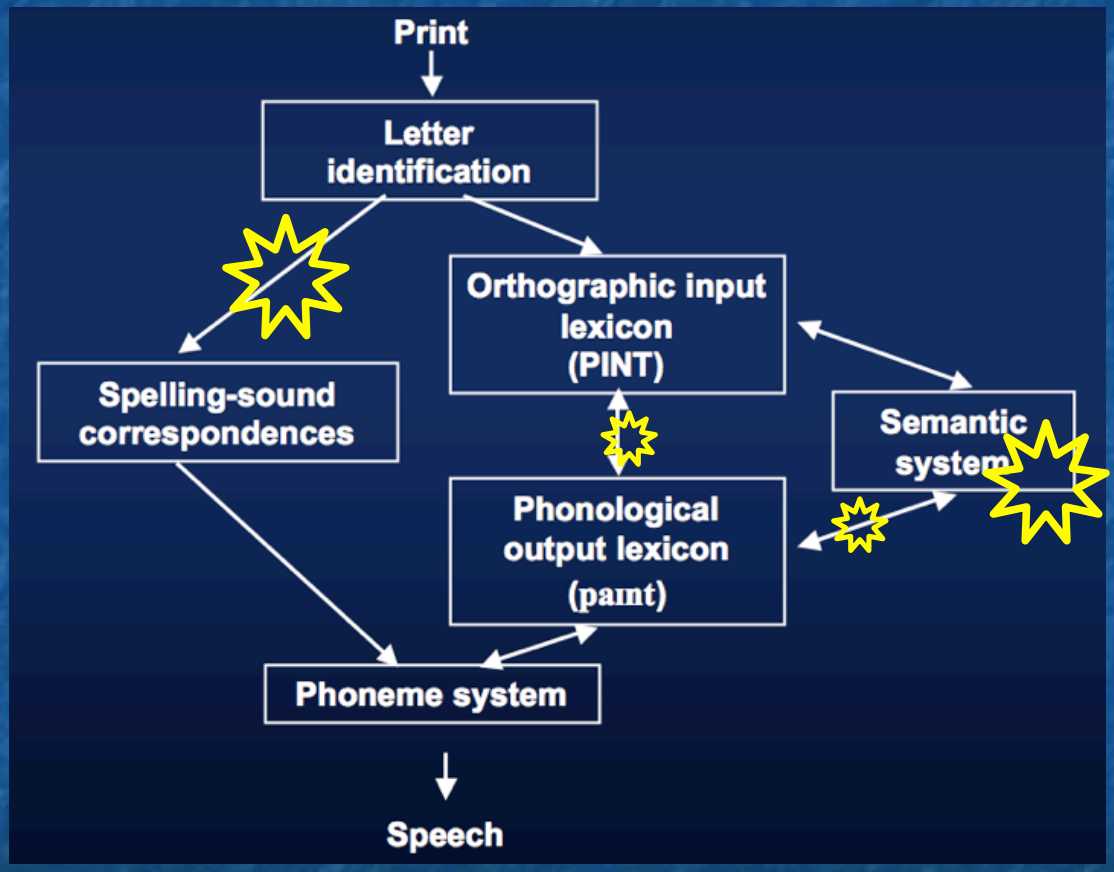
Impaired auditory-verbal short-term memory

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

cf. Coltheart (1980)



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

The Right Hemisphere Hypothesis

Coltheart (1980); Saffran *et al.* (1980)

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

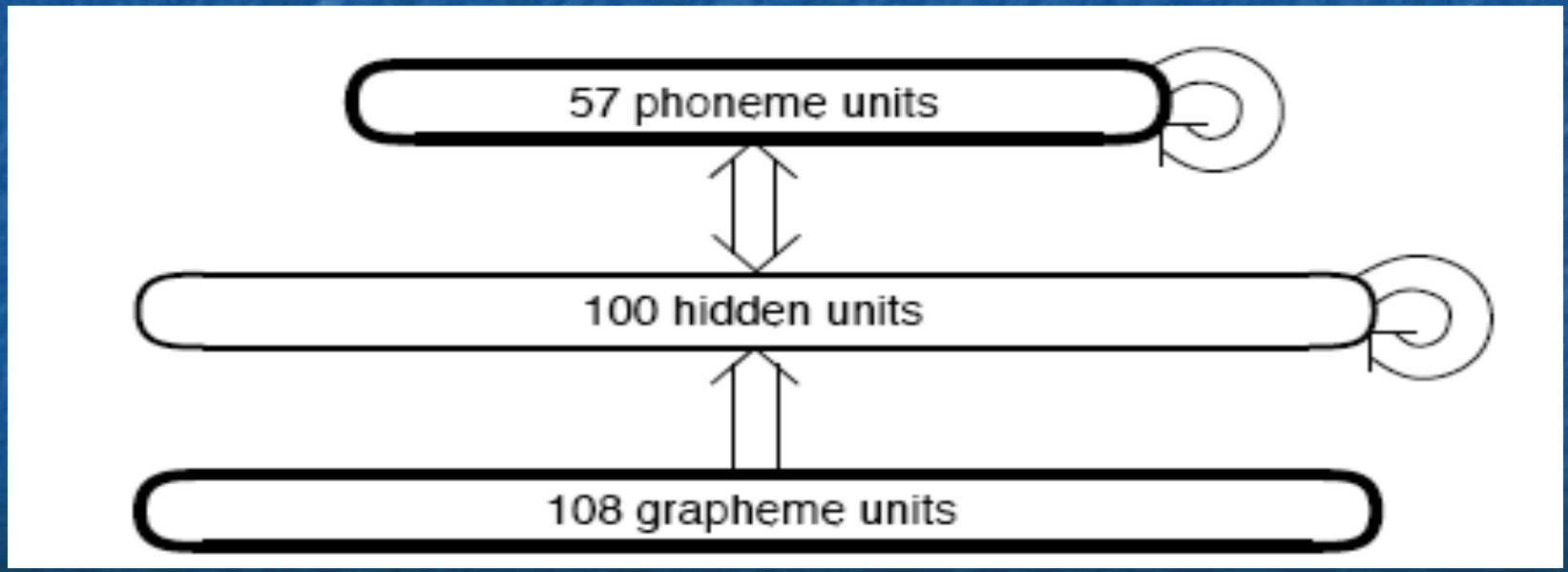
Deep dyslexic reading looks like RH language, as seen in commissurotomy patients (Michel *et al.*, 1996), lateralized presentation studies, and left hemispherectomy patients (Patterson *et al.*, 1987)

Orthographic and semantic processing in deep dyslexia reflect RH reading

Connectionist computational modelling of deep dyslexia

Hinton, Plaut, Shallice (1993)

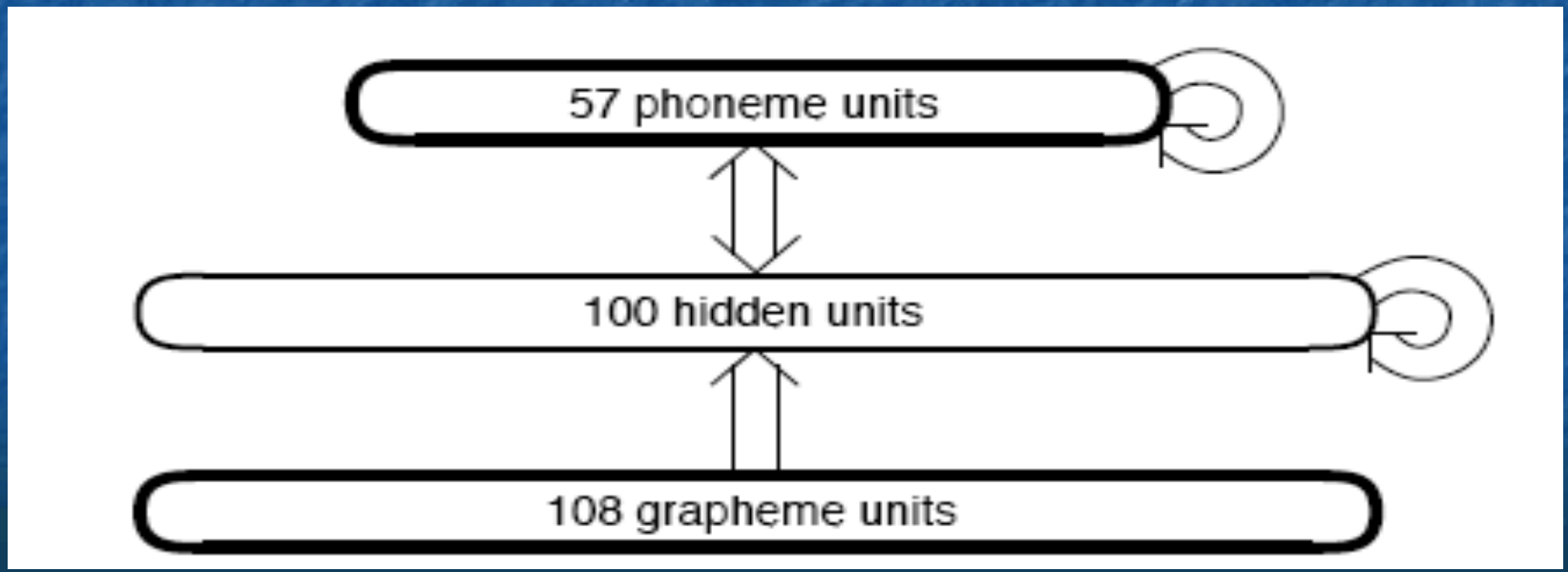
Connectionist models are good at learning quasi-regular mappings, such as orthography→phonology



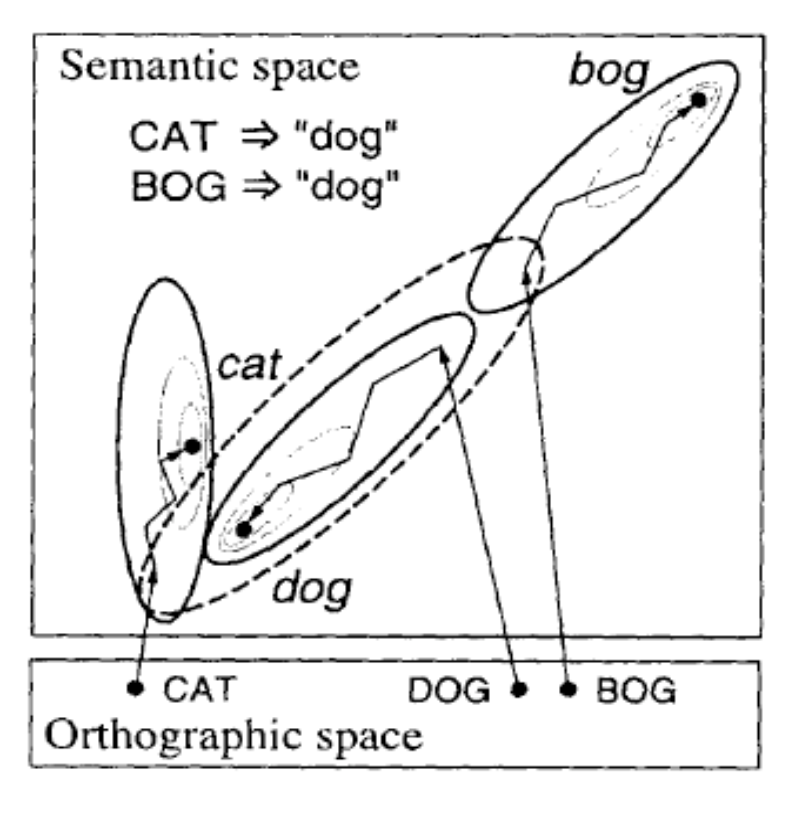
Connectionist computational modelling of deep dyslexia

Hinton, Plaut, Shallice (1993)

But any relationship with semantic representations is largely *arbitrary*. Recurrent connections can "clean up" outputs

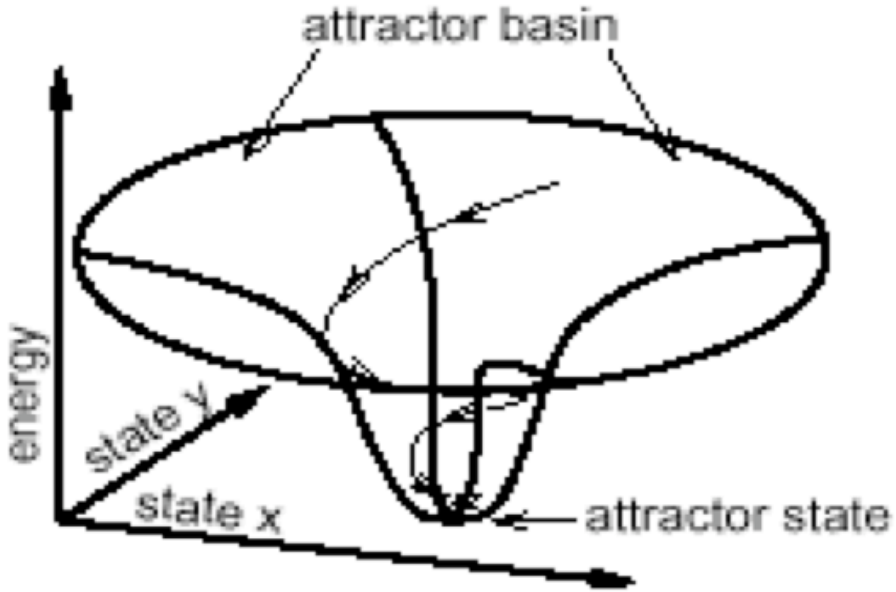


Attractors and basins of attraction



The model is trained so that the pattern of activation over its output units settles into the desired steady states (Plaut & McClelland, 1993)

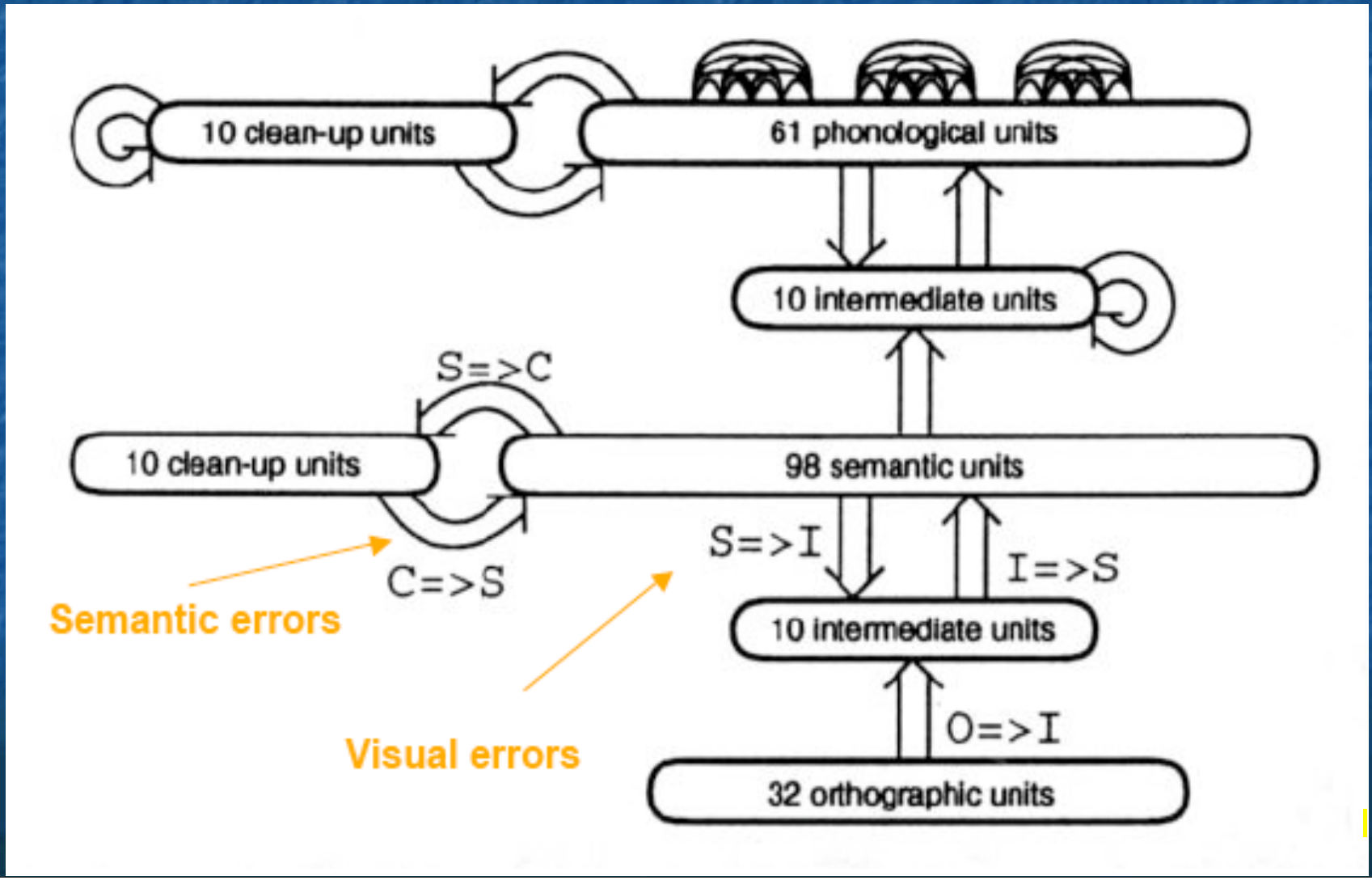
Attractors and basins of attraction



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

Modelling deep dyslexia

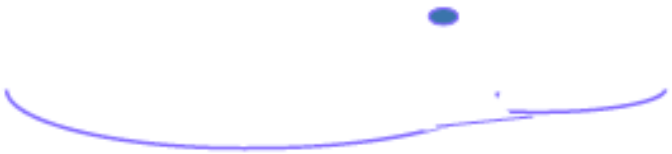
Plaut & Shallice, 1993



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.

Modelling deep dyslexia

Plaut & Shallice, 1993

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

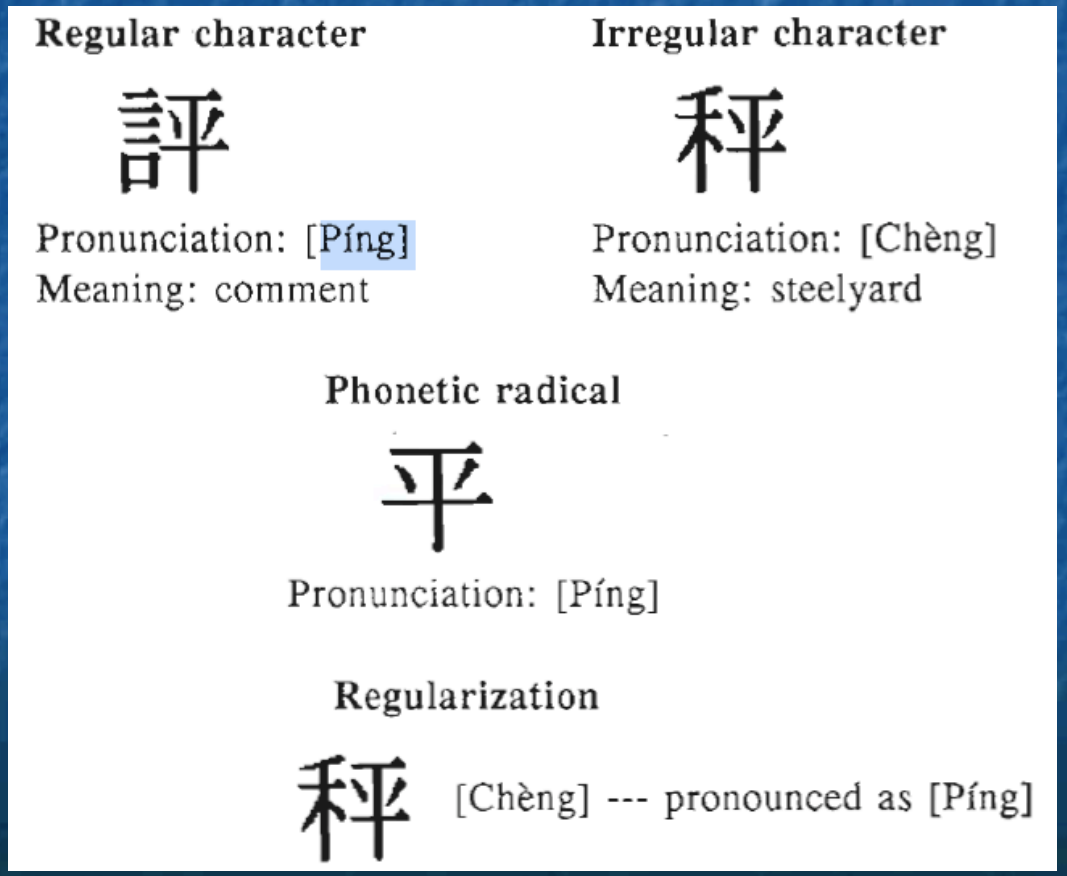
Jeffries et al. (2007)

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

Chinese (Yin & Butterworth, 1992). Deep dyslexics make semantic errors but no regularization errors



Therapy

de Partz (1986)

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