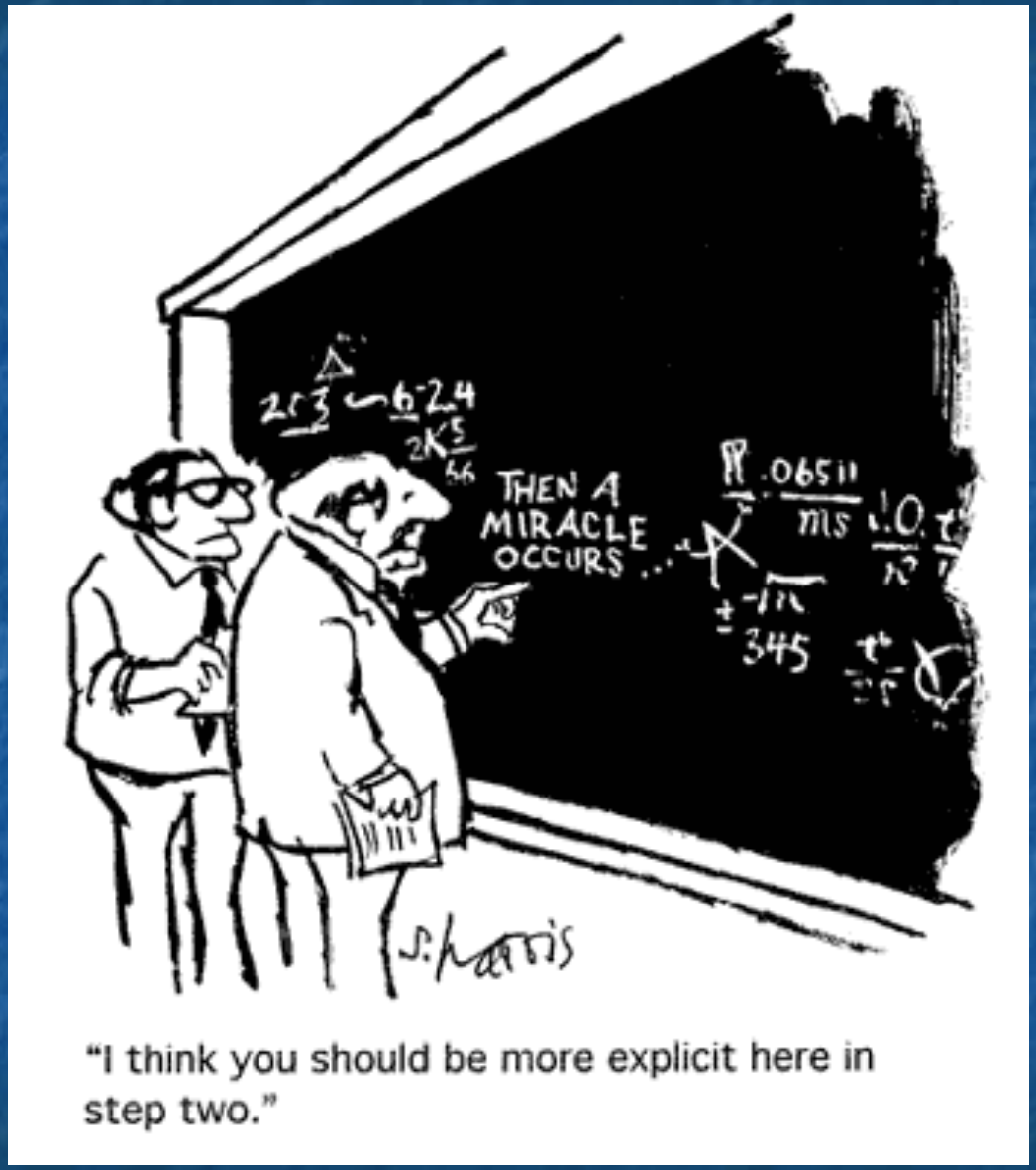
# INF1-CG 2016
# Lecture 29

# Cognitive modelling: Some examples, some advantages, some limitations

Richard Shillcock

# Today's goals

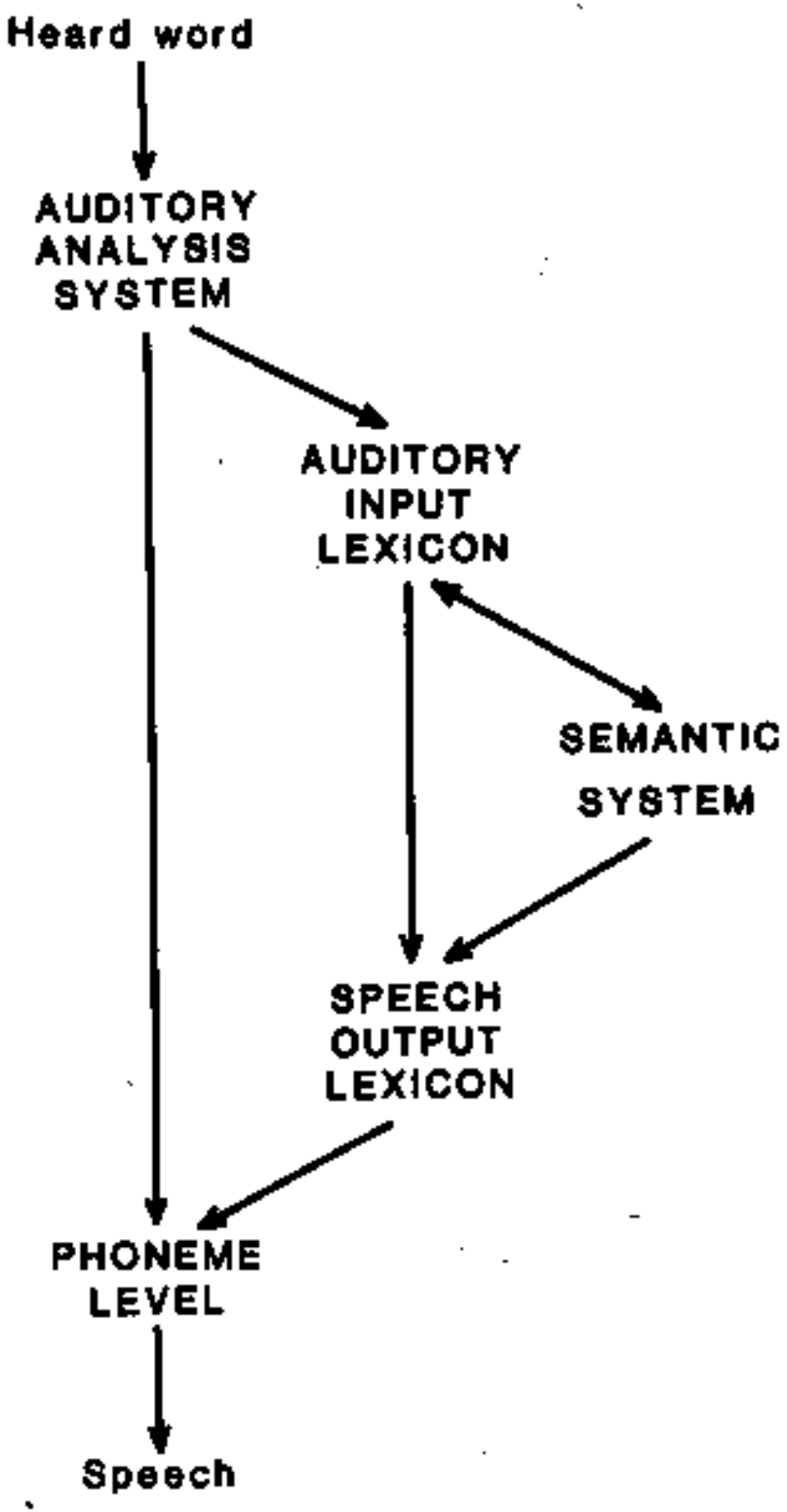



"I think you should be more explicit here in step two."

To look at some of the choices that are made in cognitive modelling and the implications that flow from them.

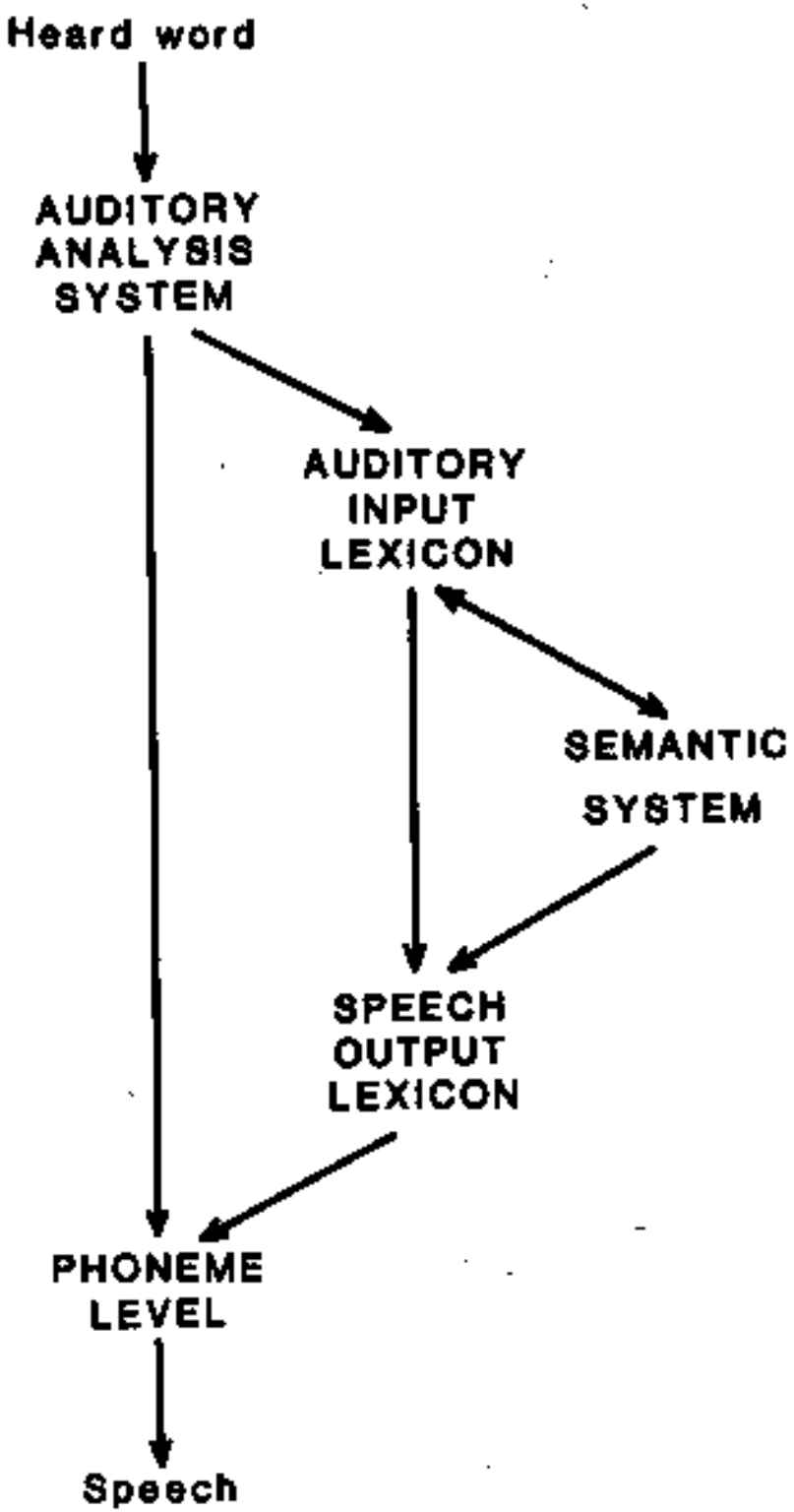
# Today's reading

McClelland, J. L. (2009). The place of modeling in cognitive science. *Topics in Cognitive Science, 1*(1), 11-38.




# "Classical" models

## Ellis & Young (1988)



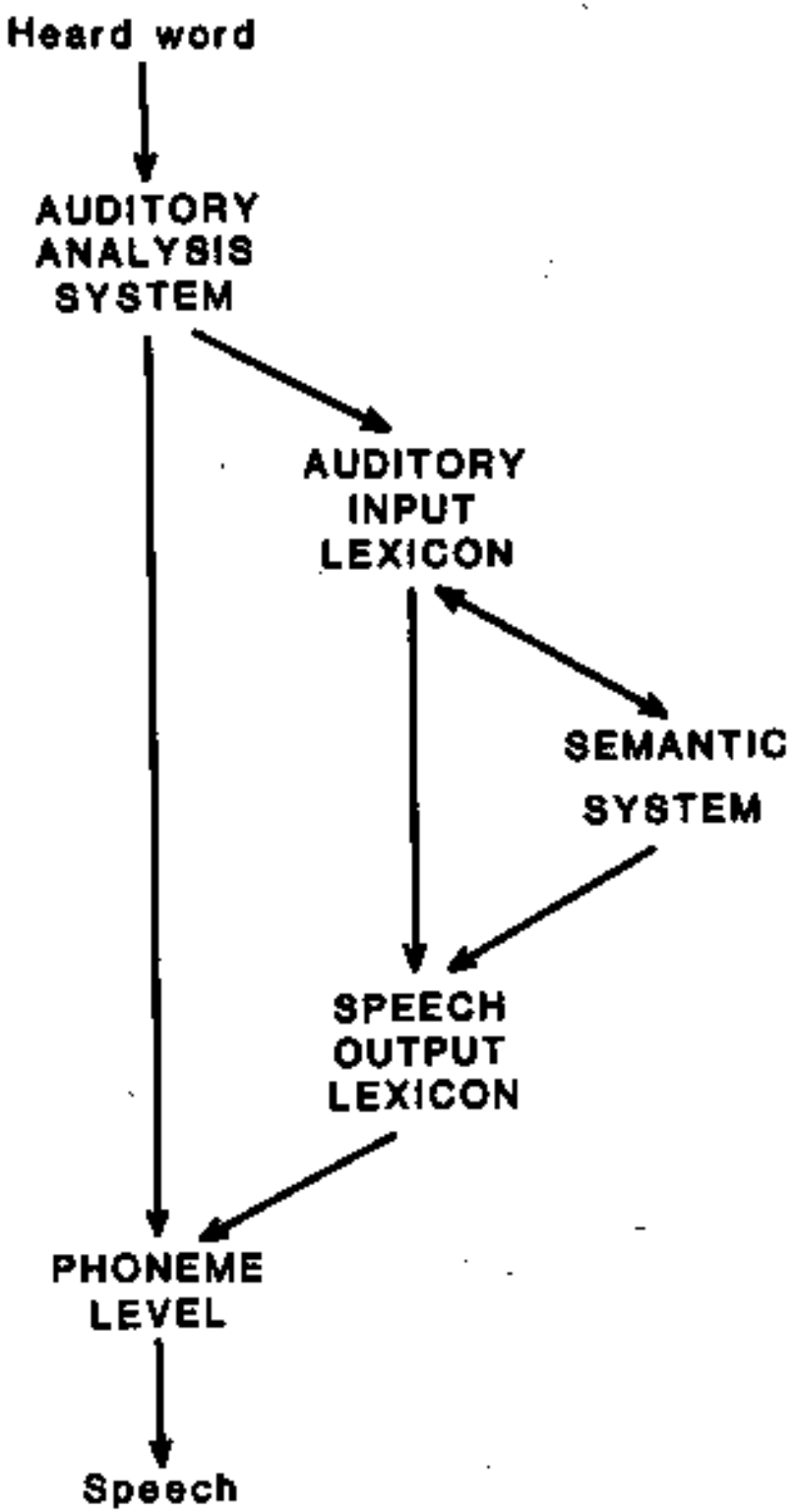

# "Classical" models

A "classical" box-and-arrow model lets us put our ideas down on paper.

It is a shorthand version of our theorizing.

It helps us to see the options for the ordered relations between the entities (and 'suggests' modifications to us).

It helps us communicate the model to other researchers.




# "Classical" models

It helps us make predictions …

… which we can test in the laboratory.

That's about it.

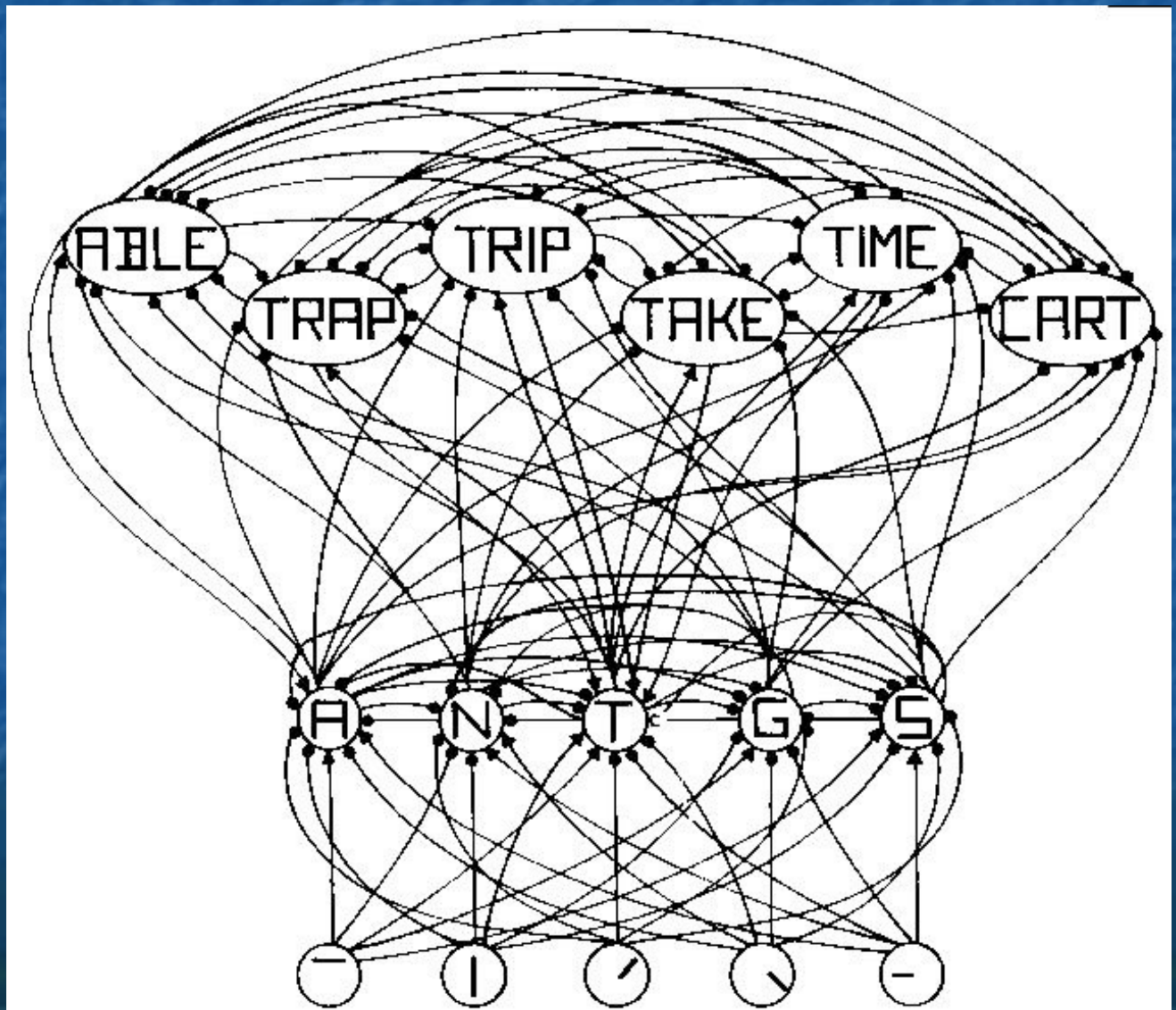
It can't *surprise* us.

It can't really persuade us we're wrong.

It can only really be as complicated as we can work through it ourselves.

# Interactive-Activation Model
# model of reading

## McClelland & Rumelhart (1981)




# Computational models

A model can be implemented on a computer; the computer runs the model automatically.

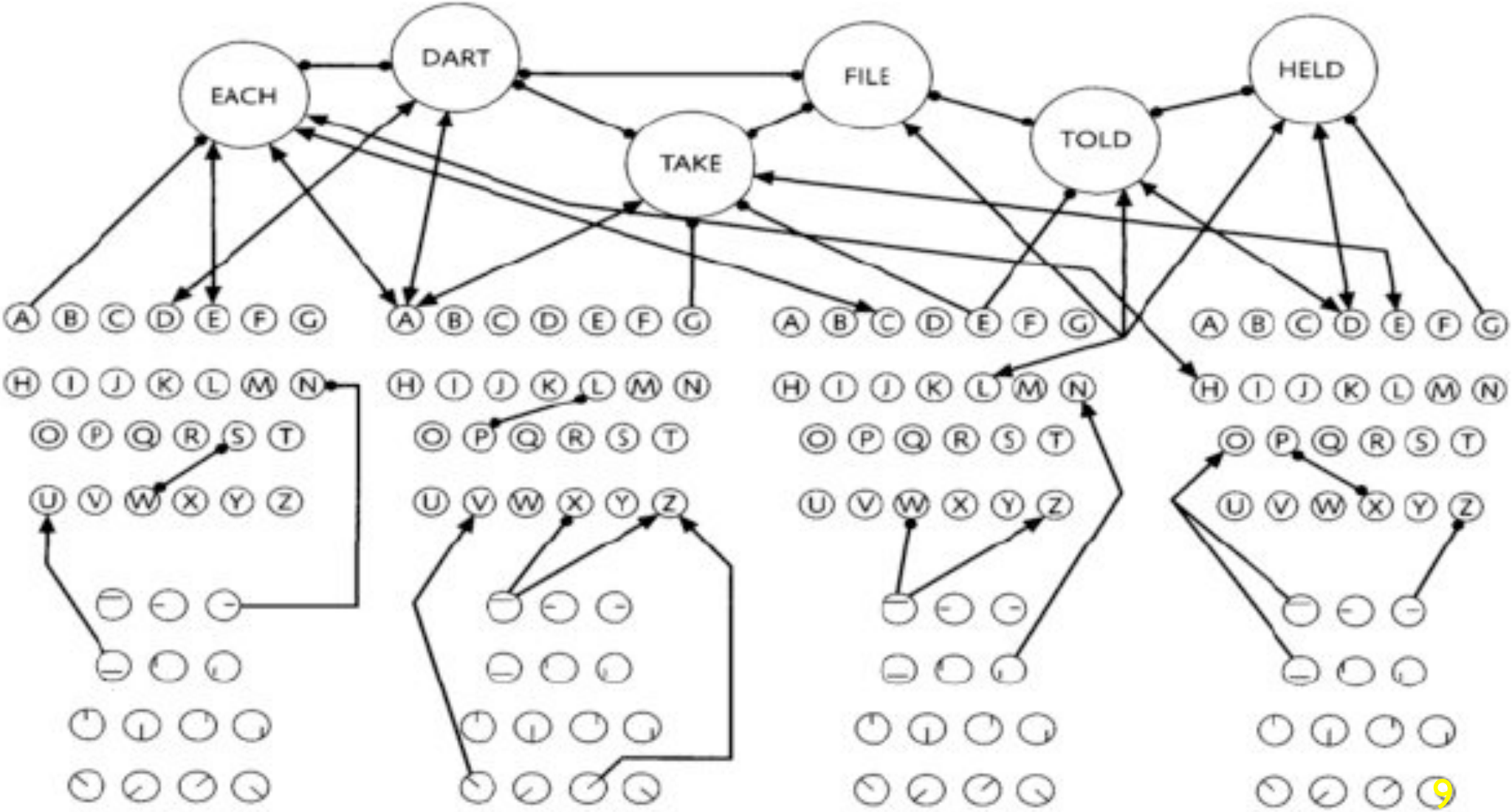
It has all the advantages of the box-and-arrow model.

But it can be hugely complex.

It can really surprise us with *emergent behaviours*.

It can test our informal theory rigorously and show us where we were wrong.

# Interactive-Activation Model
# model of reading
# McClelland & Rumelhart (1981)



# Interactive-Activation Model

The authors took existing entities (from linguists and psychologists).

They *hand-wired* the model. They told the computer exactly what to do for every individual choice it would ever have to take.

They built in a few *parameters* they could later manipulate.

They gave it an input and let it run.

They recorded its behaviour and compared it with human behaviour.

# Interactive-Activation Model

The model generated expected and unexpected behaviours.

Similar words became partly activated at the same time.

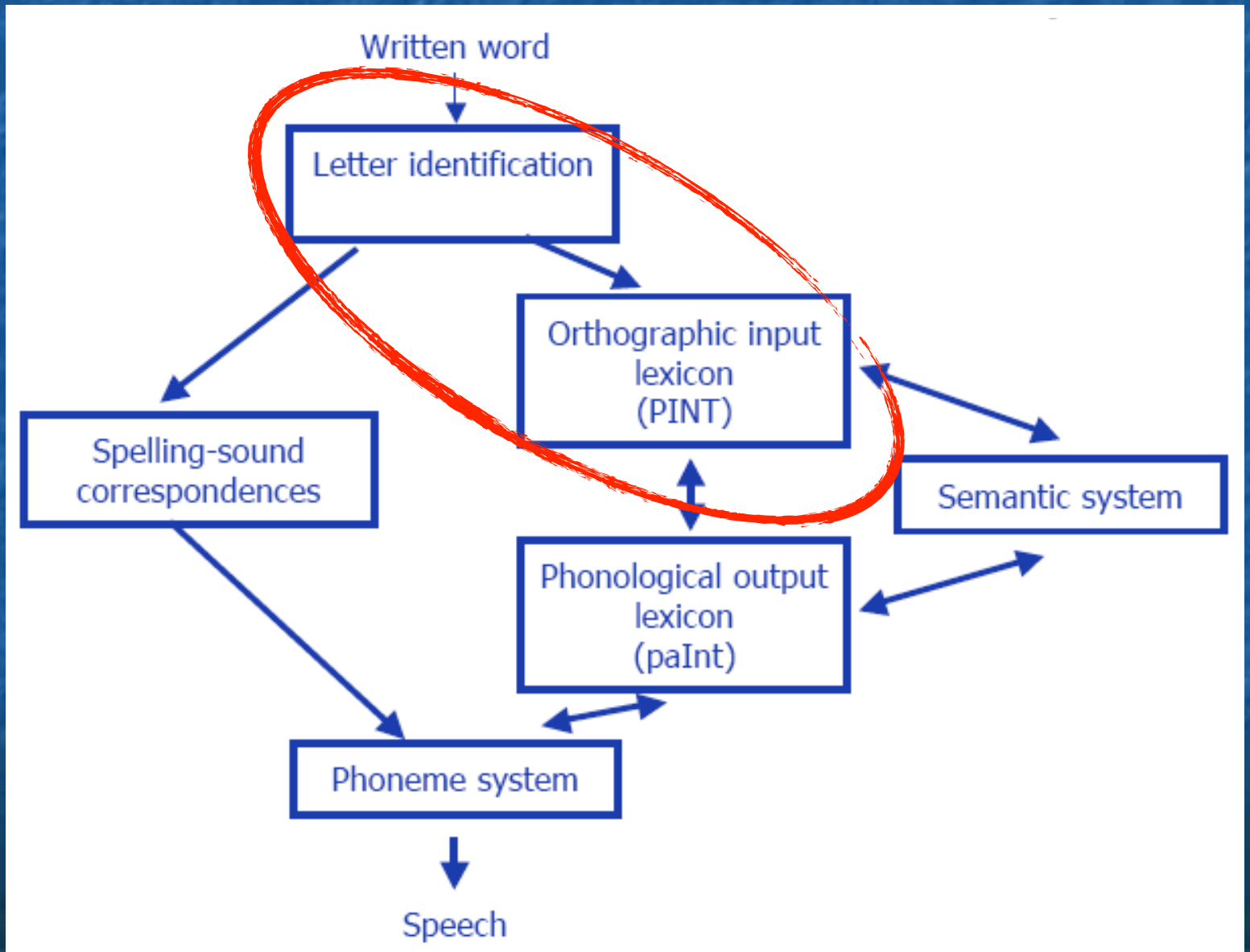
The model could 'restore' missing data: WORK

Complex conspiracies of partly activated words produced a range of behaviours.

A new *conceptual vocabulary* (e.g. 'decay' in the model's representations; 'letter slot') is produced to describe how the problem is solved.

# Dual-Route Cascaded Model (DRC)

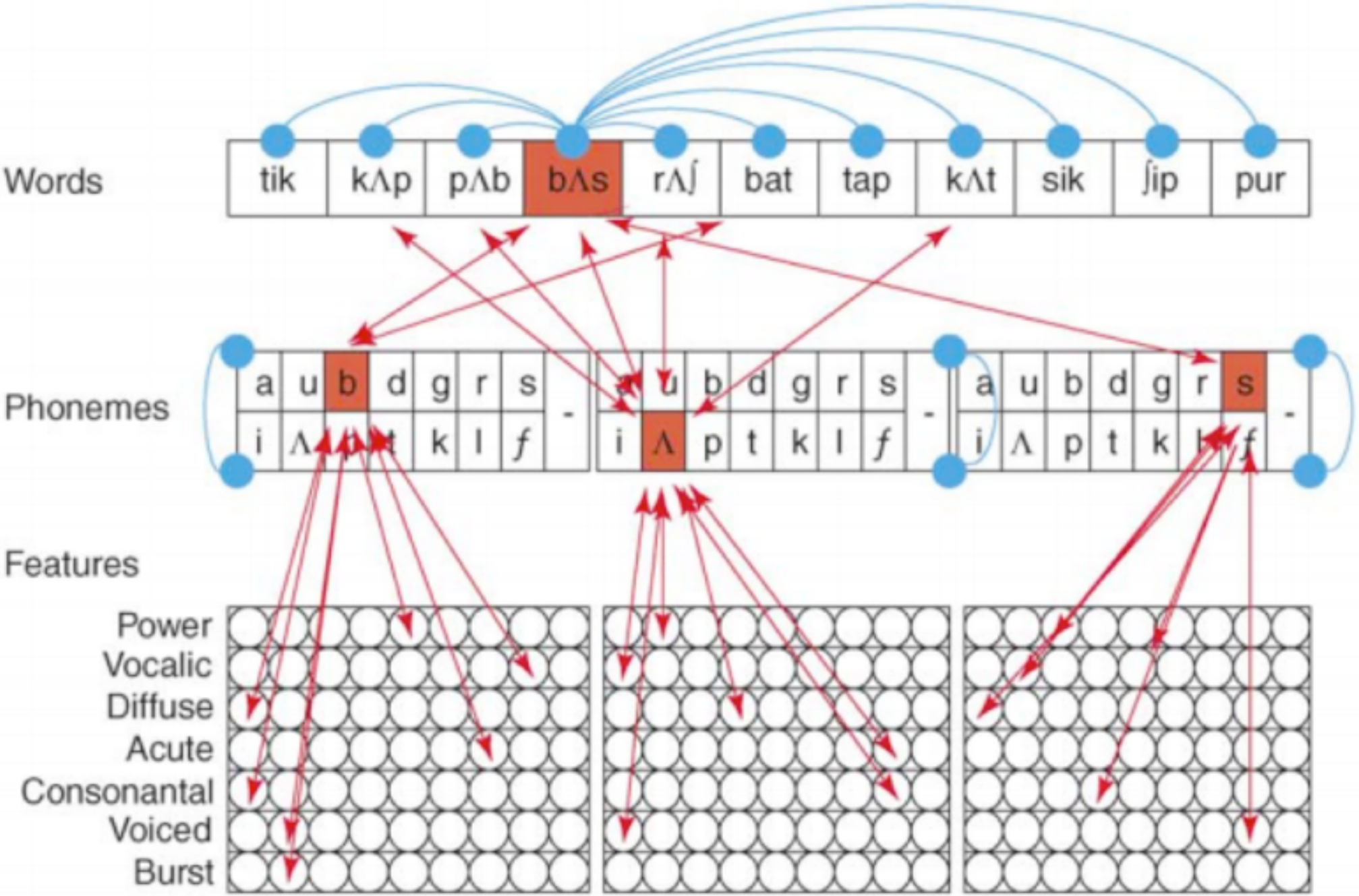
## Coltheart et al. (1993, 2002)



# Computational models

Computational models can, in principle, be added together ('nested') in a modular way (Perry, Ziegler, & Zorzi, 2007).

They can be 'lesioned' to inspect their impaired behaviour. Does it resemble dyslexic behaviours? (This applies more interestingly to connectionist models, which can learn their own internal 'representations' by example.)




# McClelland & Elman's (1986) TRACE model of speech perception

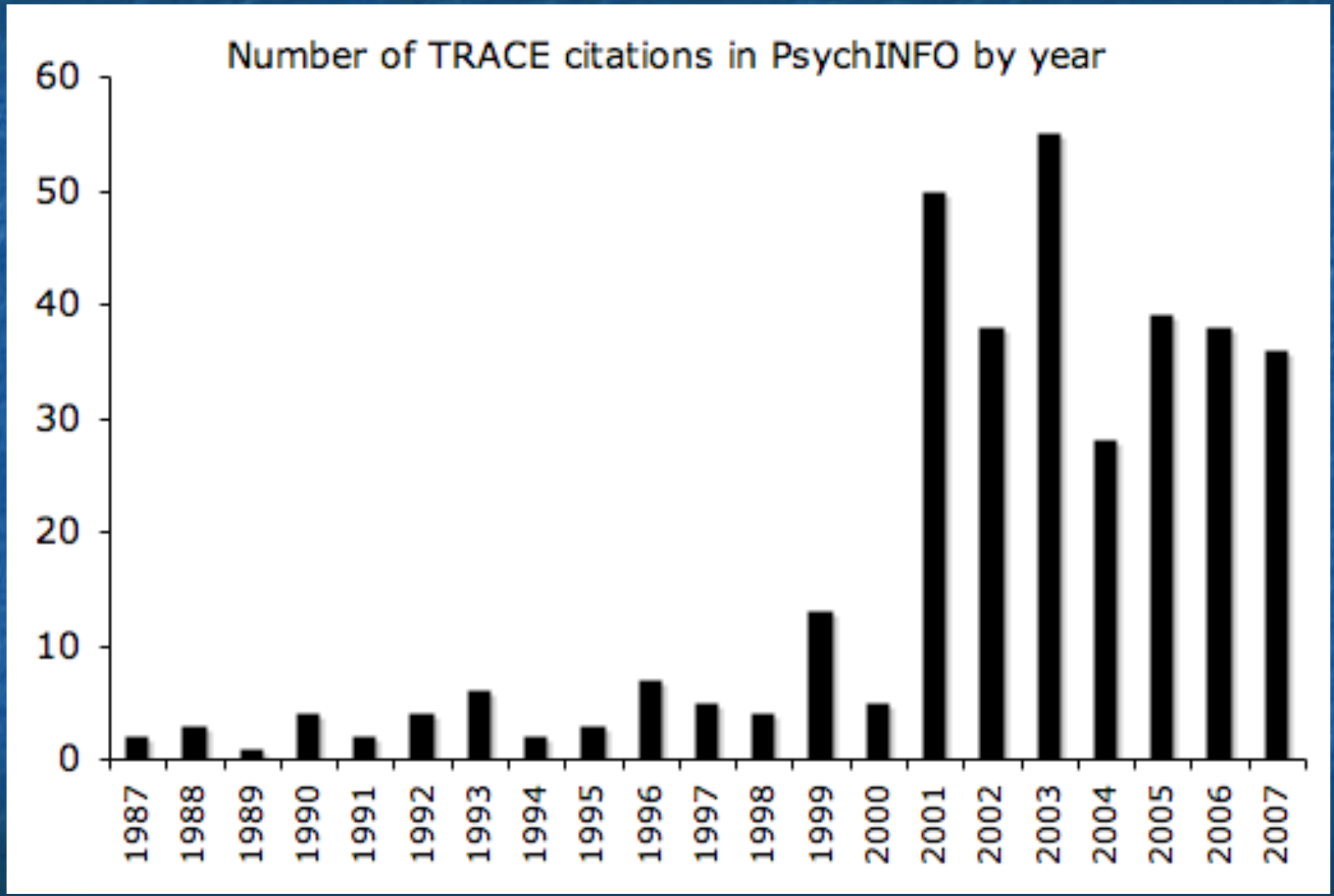
# TRACE

McClelland and Elman created TRACE as a version of the Interactive-Activation Model, but stretched out in time, to resemble speech perception.

There is a temporal dimension, composed of 'timeslots'.

It was designed to instantiate Marslen-Wilson's Cohort Model (a 'classical' model of spoken word perception) based on the phoneme-by-phoneme arrival of information about a perceived word.

# TRACE is hugely successful ...



# ... but ...

TRACE has remained in its original form, with only minor parametric explorations.

Our field contains a large number of cognitive models.

We want them to be *vehicles* of scientific exploration ...

# ... but ...

TRACE has remained in its original form.

TRACE is (trivially) defeated by new data.

TRACE has participated in a long-running debate:

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## Merging information in speech recognition: Feedback is never necessary

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# Challenges

Should our models be static or developing?

Should we be able to say something *philosophical* about the nature of our models?

Should we be able to say something about *simplicity*, *completeness*, *complexity*, *theory of knowledge*, *explanation*, …?

# References

McClelland, J. L., & Elman, J. L. (1986). The TRACE model of speech perception. *Cognitive Psychology*, *18*(1), 1-86.

Norris, D., McQueen, J. M., & Cutler, A. (2000). Merging information in speech recognition: Feedback is never necessary. *Behavioral and Brain Sciences*, *23*(3), 299-324.

Perry, C., Ziegler, J. C., & Zorzi, M. (2007). Nested incremental modeling in the development of computational theories: the CDP+ model of reading aloud. Psychological review, 114(2), 273.