

Embodiment vs. Memetics



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Artificial models of natural Intelligence

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Really:

Embodiment *and* Memetics

Where do word meanings come from?

Quick Definitions

- **Embodiment:** human intelligence is based on categories derived from our physical existence and experience. Language understanding requires sharing these categories.
- **Memetics:** language (and other cultural behavior) evolves independently of human understanding.

Outline

Where do word meanings come from?

- Why is this a question?
- Who believes in Embodiment?
- What evidence is there for Memetics?
- Ramifications for development.
- Ramifications for language evolution.

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Only semantics?

- Both Embodiment and Memetics are theories in opposition to “the Logical hypothesis.” (help wanted!)
- Intelligence must be bounded (Gigerenzer and Todd 2000, Chapman 1987, Simon...), but how?
- Implications for the nature of human reasoning, behavior, and development.
- Therefore implications for AI.

A Brief History of AI

- Founded in the 1950s.
- **Funded** in the 1960s by promising machine translation (esp. Russian). --- **Theory: Solve syntax as a program, lookup semantics in dictionary.**
- By 1980s, funders restless. --- **Theory: Semantics requires grounding in an embodied system** (Harnad 1990, Brooks 1991).
- 1990s: Robots for Language.

The Practical Question

Will embodiment solve natural language?

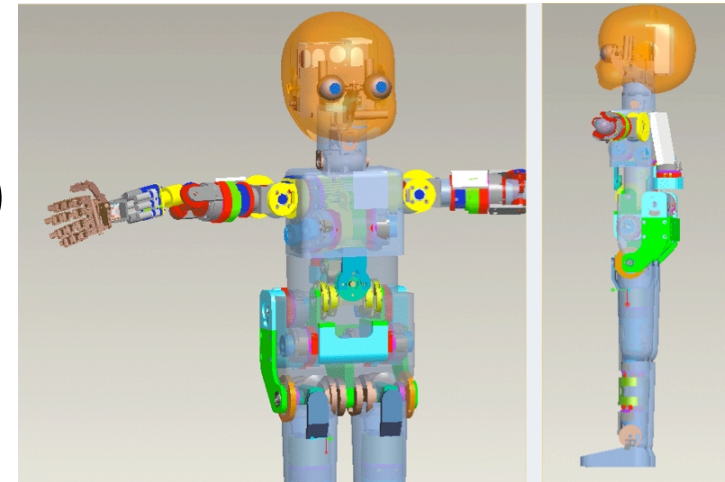
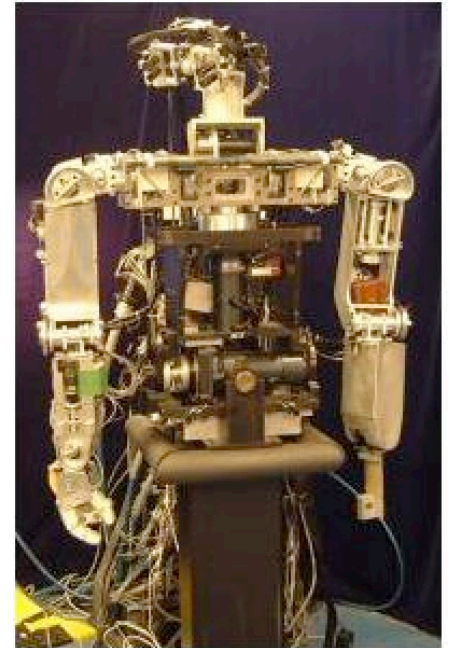
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Experiments in Embodied Cognition

- Cog: MIT AI lab / CSAIL 1993-*present*.
 - Build human 2-year-old in 5 years (Brooks & Stein 1993; Bryson 2006 *Minds & Machines*).
- RobotCub: EU (Genoa+ 15 others) €8.2M 2005-2010.
 - Build 12 human 2-year-olds in 3 years, give to psychologists to do science in 2 years.



Other Believers

- George Lakoff and Mark Johnson *Metaphors We Live By* 1980; *Philosophy in the Flesh: The embodied mind and its challenge to Western thought* 1999.
- And **evidence!**

Michael Ramscar (e.g. Boroditsky & Ramscar 2002). Arthur Glenberg (e.g. Glenberg & Robertson 2000).

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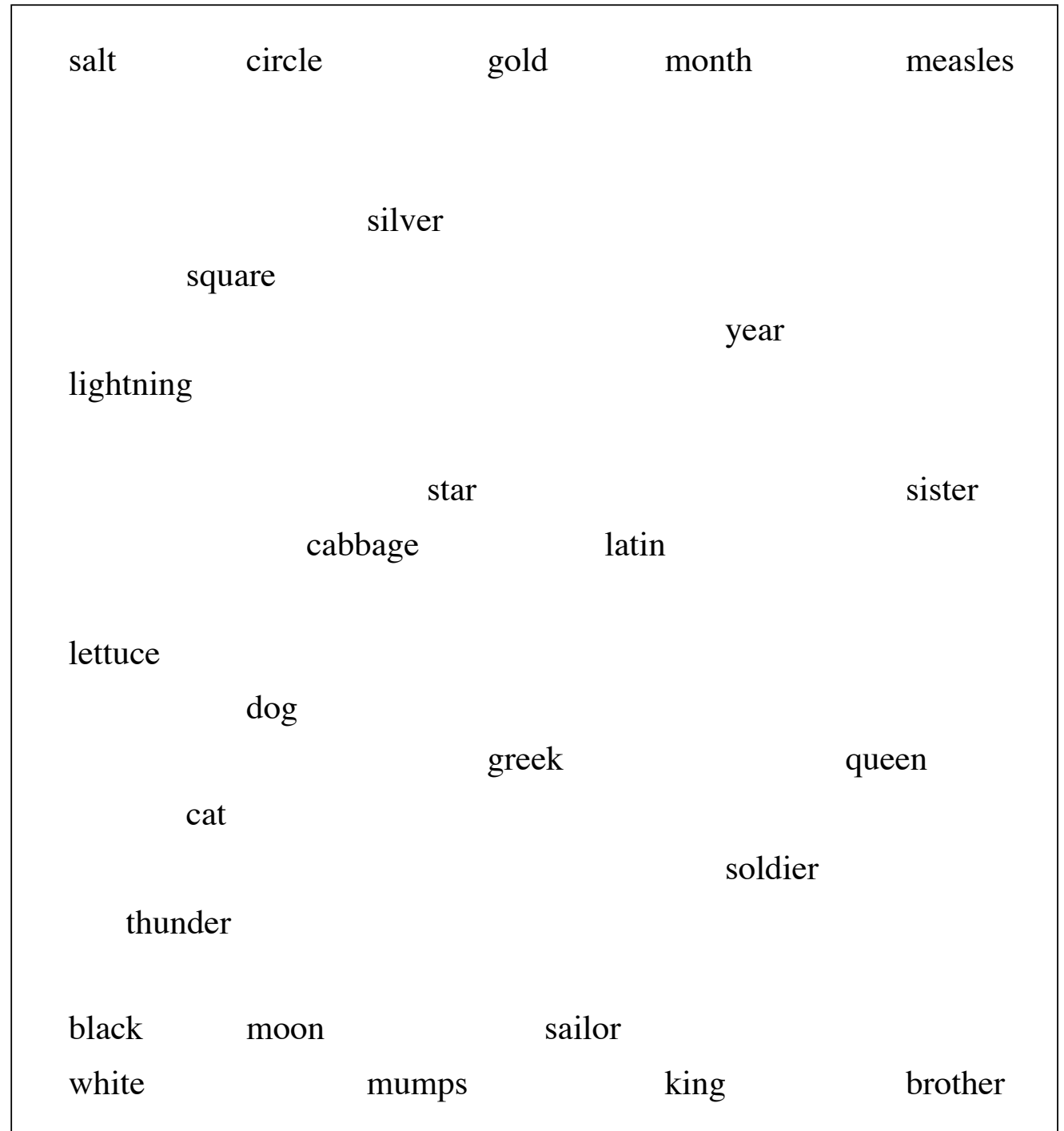
Evidence for Memetics

- Real memetics: full theory of culture evolving (requires replicators, selection, etc.)
- In this talk/paper: “meaning” acquired as it would be in a memetic process.
- Neither through embodied experience nor through reasoning, but by automatic perception of the social environment.

Memetic Semantics

- Human semantics can be replicated by statistical learning on large corpora (Finch 1993, Landauer & Dumais 1997, McDonald & Lowe 1998, Bilovich (and I) 2006).
- Only information gathered on each word's 'meaning' is what words occur in a small window before and after it.
- Normally just choose 75 **fairly** frequent words to watch out for.

**McDonald &
Lowe (1997)
replication
of Moss *et al*
(1995)
semantic
priming
results.**

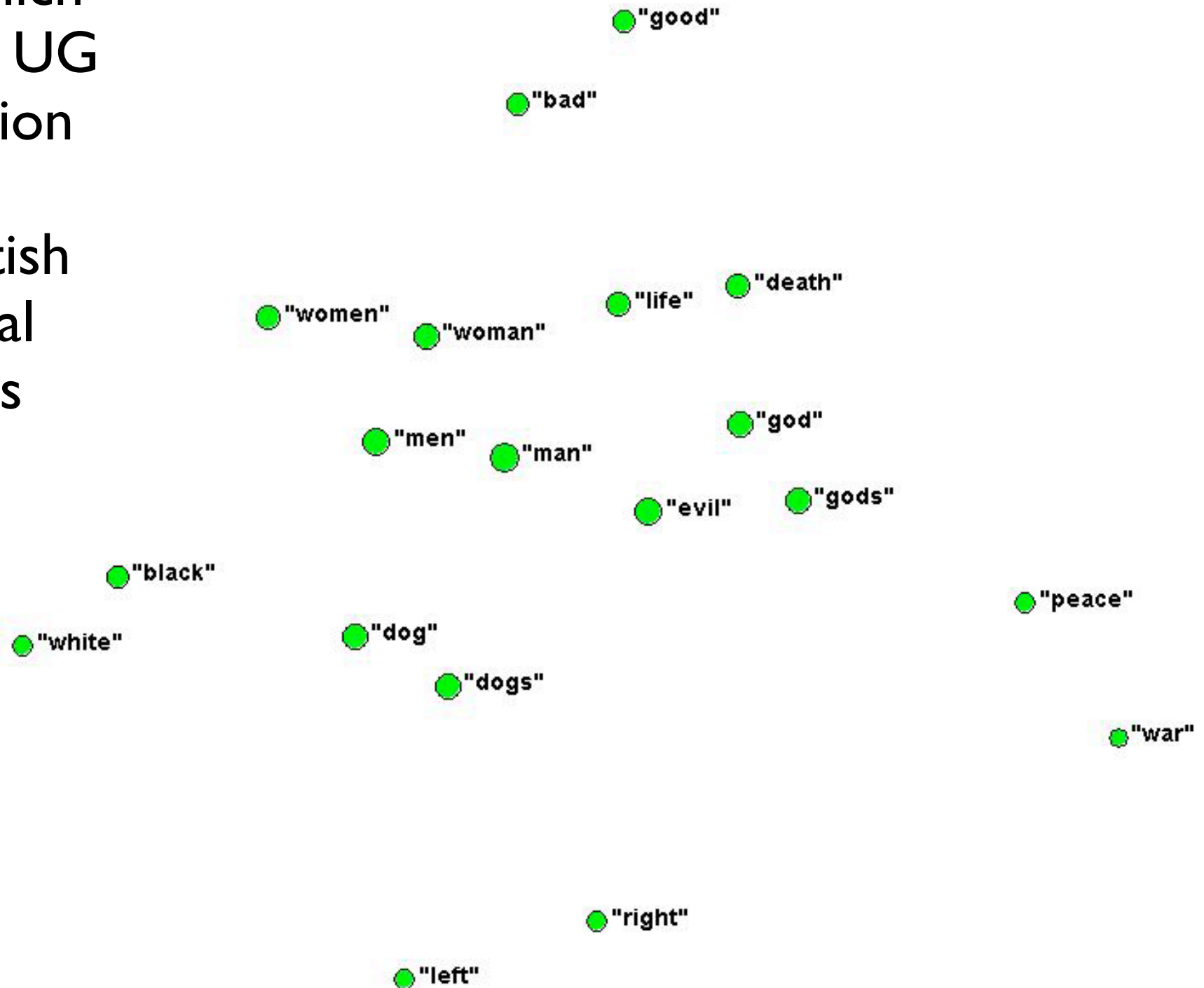


Is this enough?

- Possible both reaction times and clustering give only a “shadow” of real semantics (Lowe’s belief.)
- Bilovich & Bryson set out for further tests.
 - Goal: replicating Banaji implicit language bias data. RTs show implicit correlation between black, left, bad, violence, etc.
 - Prejudice in a corpus-based agent?

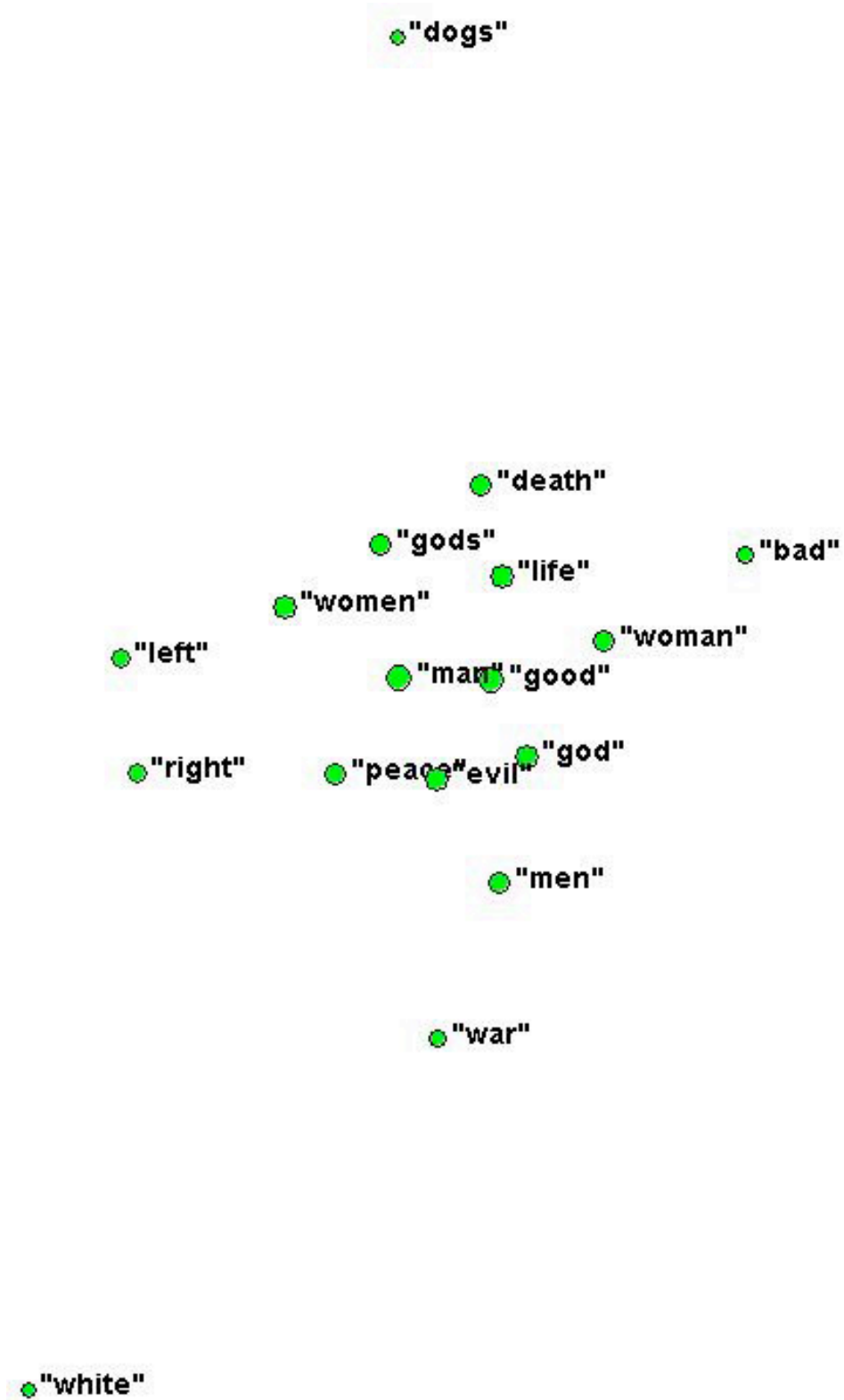
Avri Bivolich
May 2006 UG
dissertation

text: British
National
Corpus



Avri Bivolich
May 2006
dissertation

text: bible



Avri Bivolich
May 2006
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text: Shakespeare

● "dog"

● "peace"

● "man"

● "women"

● "gods"

● "death"

● "god"

● "good"

● "life"

● "men"

● "white"

● "war"

● "right"

● "black"

● "left"

● "woman"

● "bad"

Implications

- Analysis not done, but...
- Strong indication you can track conceptual change through memetic-like analysis of text.

Semantics **is** how a word is used?

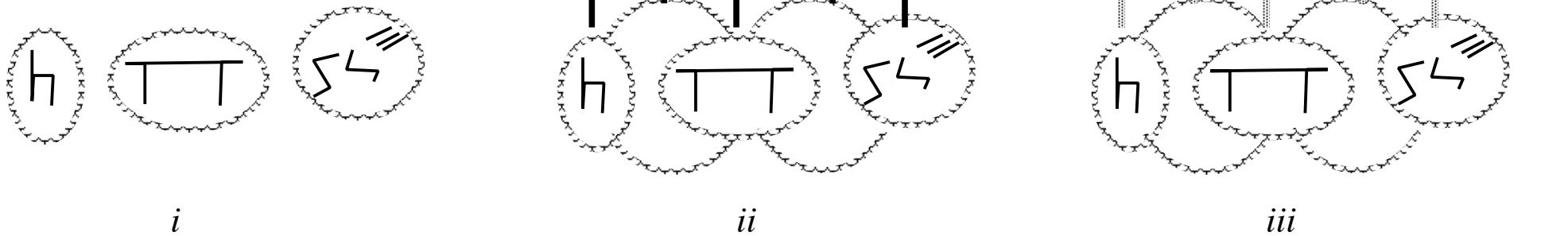
- Statistical acquisition of associative regularities (see further Quine, Wittgenstien).
- Great news for 'New AI' — semantics just like the rest of perception (not logic).

Outline

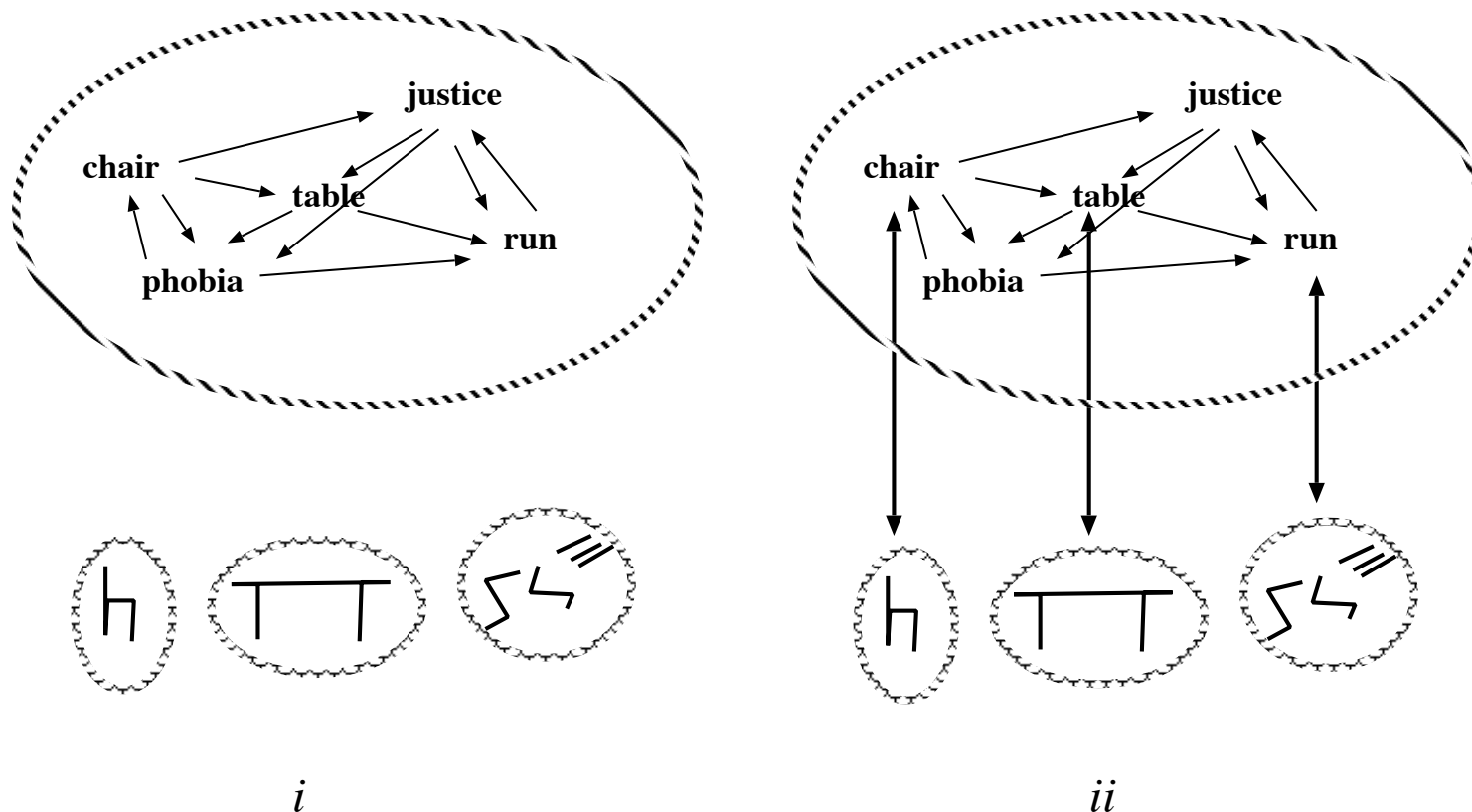
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Deacon's (1997) Theory of Semantics



Bryson's (2006) Theory of Semantics



Bryson's Theory of Semantics (1 of 2)

- **semantics**: how a word is used.
- **plant**: any part of an agent that might directly impact or be impacted upon by the agent's environment.
- **expressed behaviour**: behaviour that impacts the environment; externally observable.
- **grounded**: linked to, part of, or associated with a representation that determines an expressed behaviour.

Semantics (2 of 2)

- **understand**: connect a semantic term to a grounded concept.
- **embodiment**: having a plant. (Note: could be virtual.)
- By these definitions, you can't understand something if you aren't embodied, because understanding requires grounding.
- But you can talk sensibly about things you don't understand. (e.g. justice, semantics.)

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Evolutionary Psychology

- If memes look out for themselves, why do only humans have language? (c.f. Čače at 4pm, on the adaptive advantage of sharing knowledge.)
- **Culture**: everything you get from conspecifics non-genetically (what's missing if you're raised by wolves.)
- **Why do only humans have escalating culture?**

Culture in non-human primates

- Exists.
- Chimps (Whiten, Goodall, McGew, Nishida, Reynolds, Sugiyama, Tutin, Wrangham, & Boesch 1999, p. 684).
- Macaques (de Waal & Johanowicz 1993).



Why is ours better?

- Humans are the only species who can do precise vocal imitation (Fitch 2000). Other primates do program-level imitation. (Byrne & Russon 1992, Bryson & Wood 2005).
- Vocal imitation includes volume, pitch, timbre and (possibly most importantly) time. Humans can precisely imitate temporal sequence events of up to 3 seconds — length of phrases? (Pöppel 1994).

Warning: Speculation starts here.

Why should temporal imitation matter?

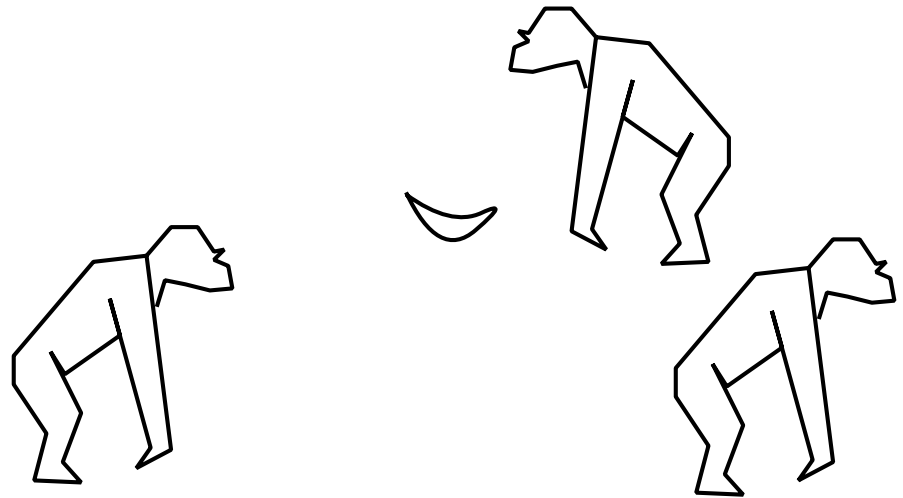
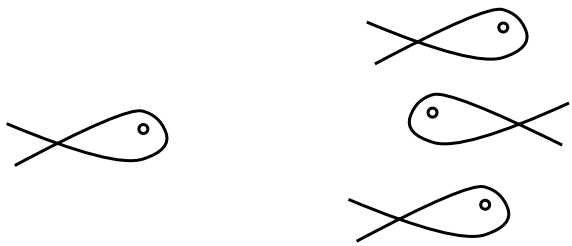
- More information contained in the ‘genetic’ substrate.
- Allows for more variation while providing redundancy, robustness .
- See further Wray (2000) on the evolution of language from phrases; Baluja (1992), Weicker & Weicker (2001), Miglino & Walker (2002) on need for diversity and redundancy in a genetic algorithm’s genome.

Why Don't Birds Talk?

- They can't hold 2nd order representations!
- Primates have uniquely complicated social organisations. (Harcourt 1992).
- Almost all species remember how group-mates behave with respect to themselves (tit-for-tat).
- But only primates behave as if they keep track of each other's social behaviour.

	ego
Roy	5
Thelma	2
Eunice	7
Harry	-1

	Roy	Thelma	Eunice	Harry
Roy	-	5	2	-4
Thelma	7	-	8	4
Eunice	-3	8	-	4
Harry	-1	3	5	-



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Hypothesis: These 2nd order representations are the basis of compositionality in language.

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Conclusions

- Human semantics can be replicated without embodiment.
- May explain some of the hard questions of language learning.
- Memetics may provide useful intelligence without **understanding**.
- Humans may be uniquely well-adapted memetic hosts.

Thanks!

Ivana Čače, Avri Bilovich, Mark Wood,
Will Lowe, Mark Johnson, Andy Whiten,
many Evolution of Language people.

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Why is Social Learning Interesting?

- It provides information to the agents faster than they can get it themselves.
- It is a second evolutionary system (besides genetics) that determines where behaviour comes from.
- A **culture** can learn far faster than the average individual.

Learning from Past Mistakes

- Logic is **not** the language of thought.
- Intelligence without representation can't learn.
 - *Representation* is just the means of storing information you retain when you learn something.
- Embodiment?