Language Needs $2^{nd}$ Order Representations and A Rich Memetic Substrate

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The Questions of Evolution of Language

1. Why do humans have language?
2. Why don’t any other species?
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1. Why do humans have language?
2. Why don’t any other species?

Because only humans have both:

- A sufficiently rich replicable substrate to support memetic evolution within generations, and
- The capacity for 2\textsuperscript{nd} order representations to support compositionality.
Outline

- Language, Utility and Memetics
  - Cultural vs. Individual Learning
  - Statistical Learning of Semantics
- Why are We Unique?
  - Cultural Learning in Non-Human Primates
  - The Substrate Argument
    - $2^{nd}$ Order Representations
- Conclusion
Outline

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What is Culture For?

- Useful if you can learn faster from your conspecifics than on your own (imitation vs. individual learning.)
- Is knowledge without understanding any use?
  - Are books any use?
  - Can you drive a car you can’t fix?
Language without Embodiment

Human semantics can be replicated by statistical learning on large corpora (Finch 1993, Landauer & Dumais 1997, McDonald & Lowe 1998).

• 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.
Semantics *is* How a Word is Used

- See further Quine (1960), Wittgenstein (1958).
- Implies syntax is a part of semantics.
- Can use same statistical method to get syntactic categories by using 75 *most* frequent (closed class) words.
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Cultural Learning in Non-Human Primates

- Exists — transmit behavior socially.
- 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).
- Vocal imitation includes volume, pitch, timbre and (possibly most importantly) time.
- Humans can precisely imitate temporal events of up to 3 seconds — length of phrases? (Pöppel 1994).
- *Might* be possible with gestures if could do temporal replication, DoF in motion.
Why is Perfect Temporal Imitation Useful?

- More information contained in the genetic substrate.
- Allows for more variation while providing plenty of opportunity for redundancy, robustness.
- See further Wray (2000) on the evolution of language from phrases.
- See further Baluja (1992), Weicker & Weicker (2001), Miglino & Walker (2002) or current work by C.Watkins on the importance of diversity and redundancy in the genome for GAs.
So Why Don’t Birds Talk?

- Can’t hold 2\textsuperscript{nd} order representations!
- Primates have uniquely complicated social organizations. (Harcourt 1992)
  - Almost all species remember how group-mates behave with respect to themselves (tit-for-tat).
  - But only primates (even monkeys) behave as if they keep track of each other’s social behavior.
  - 2-D vs 1-D representation of relationships.
- Hypothesis: These 2\textsuperscript{nd} order representations are the basis of compositionality in language.
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## Conclusion

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1-D Relationships

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2-D Relationships

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Reflective 2-D Relationships

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