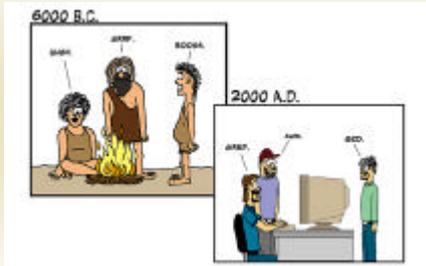
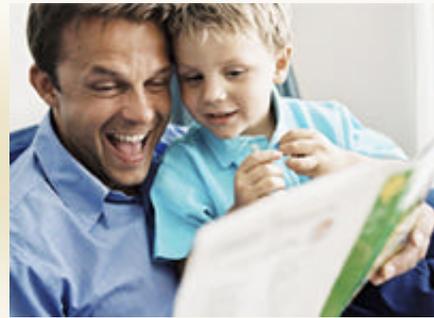


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Overview

- Joint Attention and language development
- Joint Attention and language evolution
- Research Question and hypotheses
- Simulation: the Talking Heads experiment
- Method: Language Games
- Results
- Conclusion

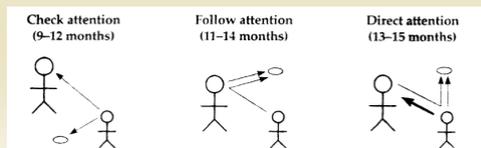
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Joint Attention

- Joint Attention: triadic relations emerging at nine months of age



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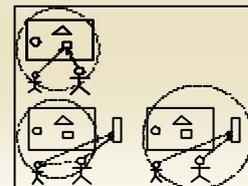
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Joint Attention

- Checking vs. following direction: same scope vs. enhancing scope of attention

sharing attention

following attention

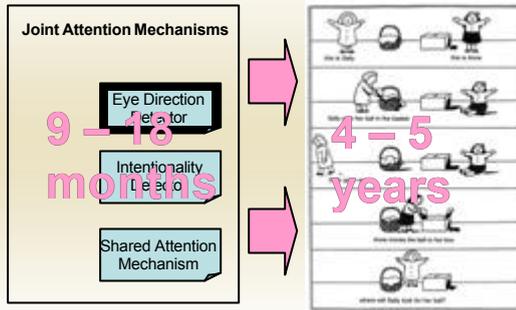


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Joint Attention vs. Theory of Mind



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Joint Attention and language development

- Language acquisition develops synchronously with development of Joint Attention and Theory of Mind

Age	Language acquisition	ToM acquisition
0-9 months		ID and EDD
9-18 months	Going from 6 to 40 words	SAM
24 months	311 words	Development of ToM
30 months	575 words	Development of ToM
48 months	Further development of vocabulary	False Belief Test
60 months	Further development of vocabulary	Opaque Context Test

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Joint Attention and language evolution

- Michael Tomasello: man and ape share 99% of genetic material
- Yet enormous difference in cognitive skills (language!)
- Solution: Joint Attention enables *cultural learning*
- Only *one* biological adaptation needed!



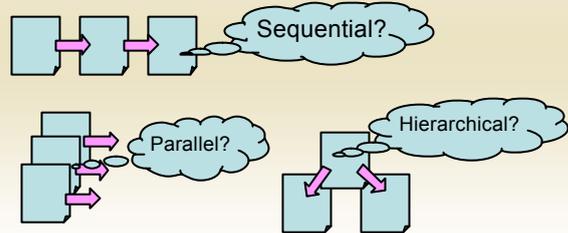
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Joint Attention and language evolution

- How are Joint Attention, Theory of Mind and Language Evolution related?

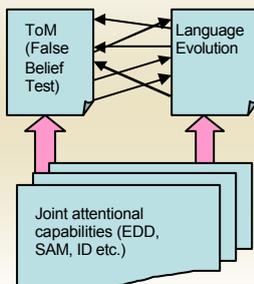


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Hypothesis from the literature



Current hypothesis for the relation between joint attention, Theory of Mind and Language Evolution:

Escalator model: Joint attention is prerequisite, ToM and Language Evolution build on each other to further develop

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Research Questions

- In how far is Joint Attention important, necessary, or even crucial for language evolution? (And, what type of joint attention?)
- Is Joint Attention helpful in ambiguous situations (as a precursor to false beliefs?)
- Use computational simulations to investigate these questions!

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Computational Simulations

- Use *Language Games* as a form of computational simulation (Steels, Vogt, ...)
- Indirect evidence from a sort of language developmental simulation!



Talking Heads experiment, 1999, investigated *Lexical Grounding* in robots

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Computational Simulations

[A] select an object on the whiteboard. (red triangle)
 [A] find label with highest weight value for 'red'
 [A] communicate 'HJSOSL' (meaning 'red')

[B] look up 'HJSOSL' (highest weight for 'circle')
 [B] gaze at blue circle



[A] notice B does not look at a red object
 [A] communicate 'NAK'
 [A] gaze at red triangle

[A,B] update weights

This is an example of a Guessing Game using feedback

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Language Games

- Guessing Game (Steels, Vogt)
 - * uses **feedback** as mechanism
- Observational Game (Oliphant)
 - * uses **sharing attention** as mechanism
- Selfish Game (uses **none**)
- Observational/JA Game
 - * joint attention enhancements
 - * uses **following** and **directing** attention

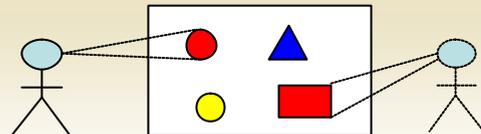
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Language Games – methods

- Base line condition:
 2 agents, 4 objects with 3 possible colors and 3 possible shapes each



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Language Games – methods

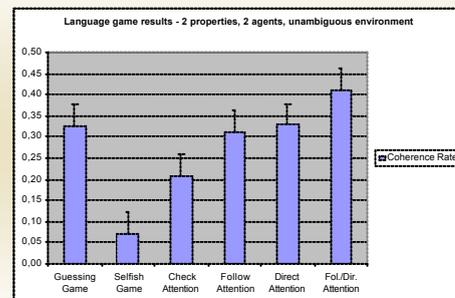
- Altered conditions:
 - 3 agents instead of 2 (alternating games)
 - 3 attributes (color/shape/size) instead of 2
 - Ambiguous environments (A saw red triangle, B saw red rectangle)
- These conditions used to test for interactions...

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Results

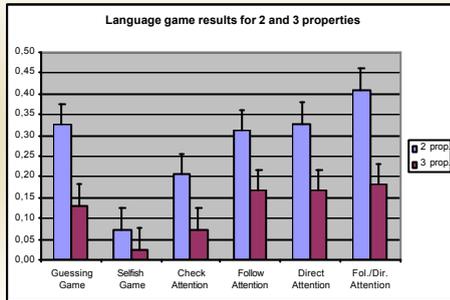


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Results

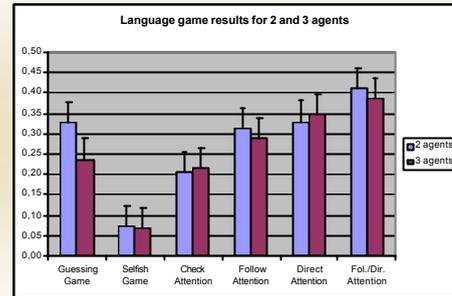


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Results

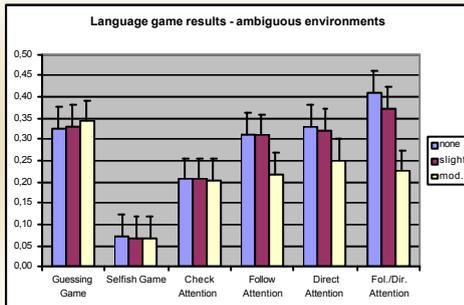


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Results



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Conclusions

- Joint attention does help, especially in more complex situations
- In more simple situations, feedback is important as well
- Joint Attention does not help in ambiguous situations: we'll need a Theory of Mind to resolve these!
- These results lend credence to the escalator model

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