

Joint Action & the Emergence of Mindreading

What are modules? & what is their role in development?

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Outline

Why we need a notion of modularity (§0)

There is a problem—current accounts of modularity are inadequate (§1).

I have a solution (§2).

This solution implies a constraint on how modules might explain cognitive development (§3).

Illustration: speech perception (§4).

Why we need a notion of modularity (§0)

1. There are subjects who can pass A-tasks but cannot pass B-tasks.
2. These subjects' success on A-tasks is explained by the fact that they **can** represent (false) beliefs
3. These subjects' failure on B-tasks is explained by the fact that they **cannot** represent (false) beliefs

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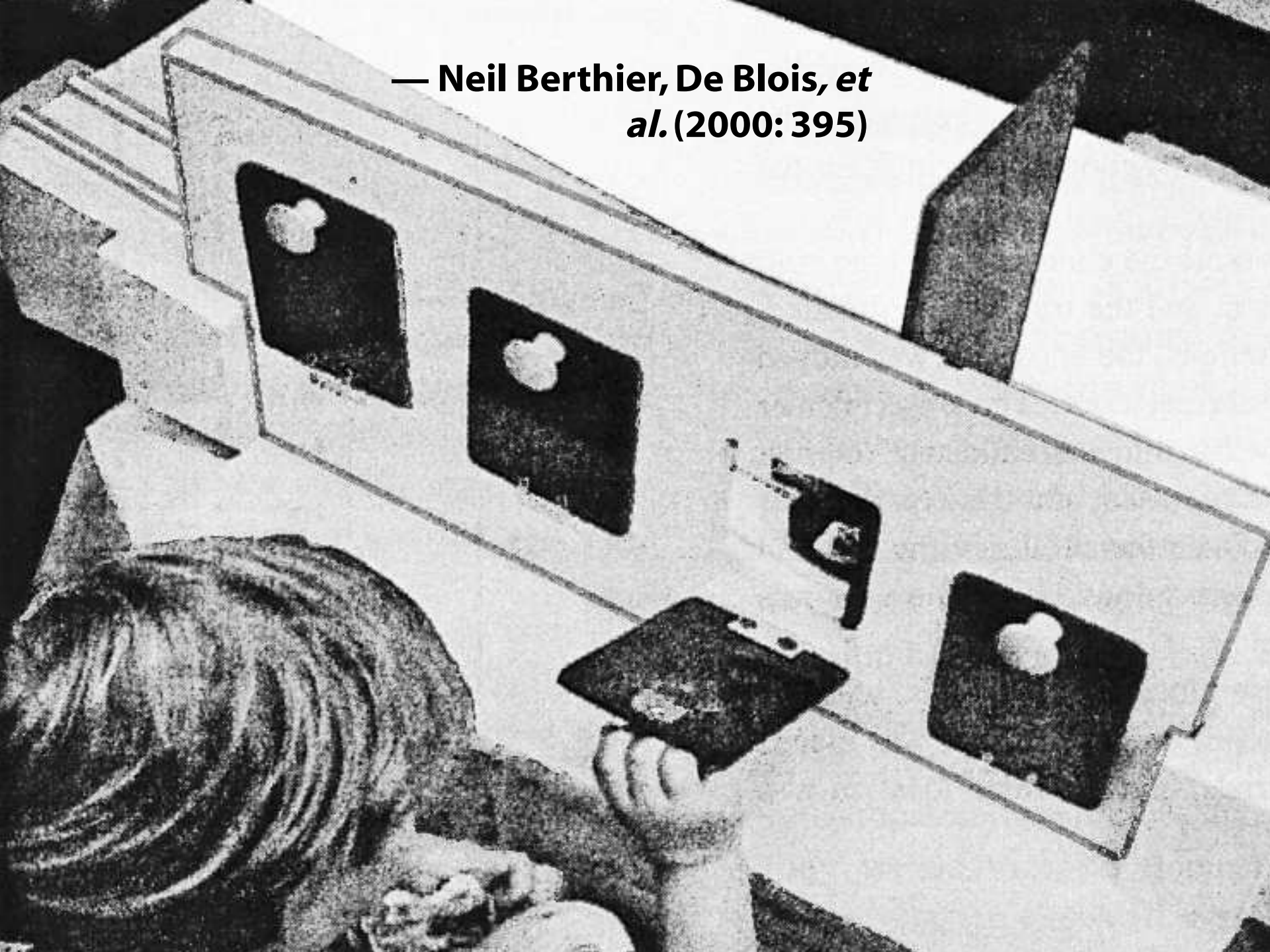
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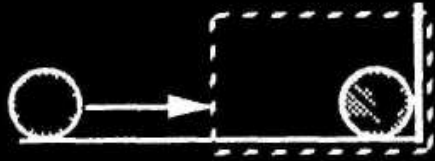
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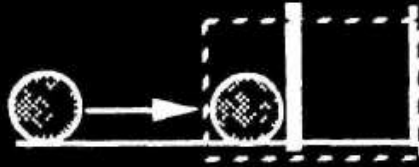
— Neil Berthier, De Blois, *et al.* (2000: 395)



habituation



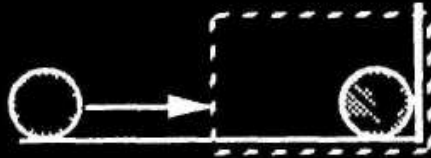
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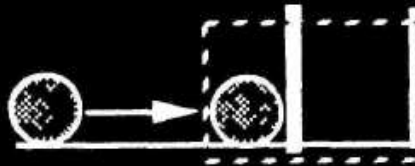
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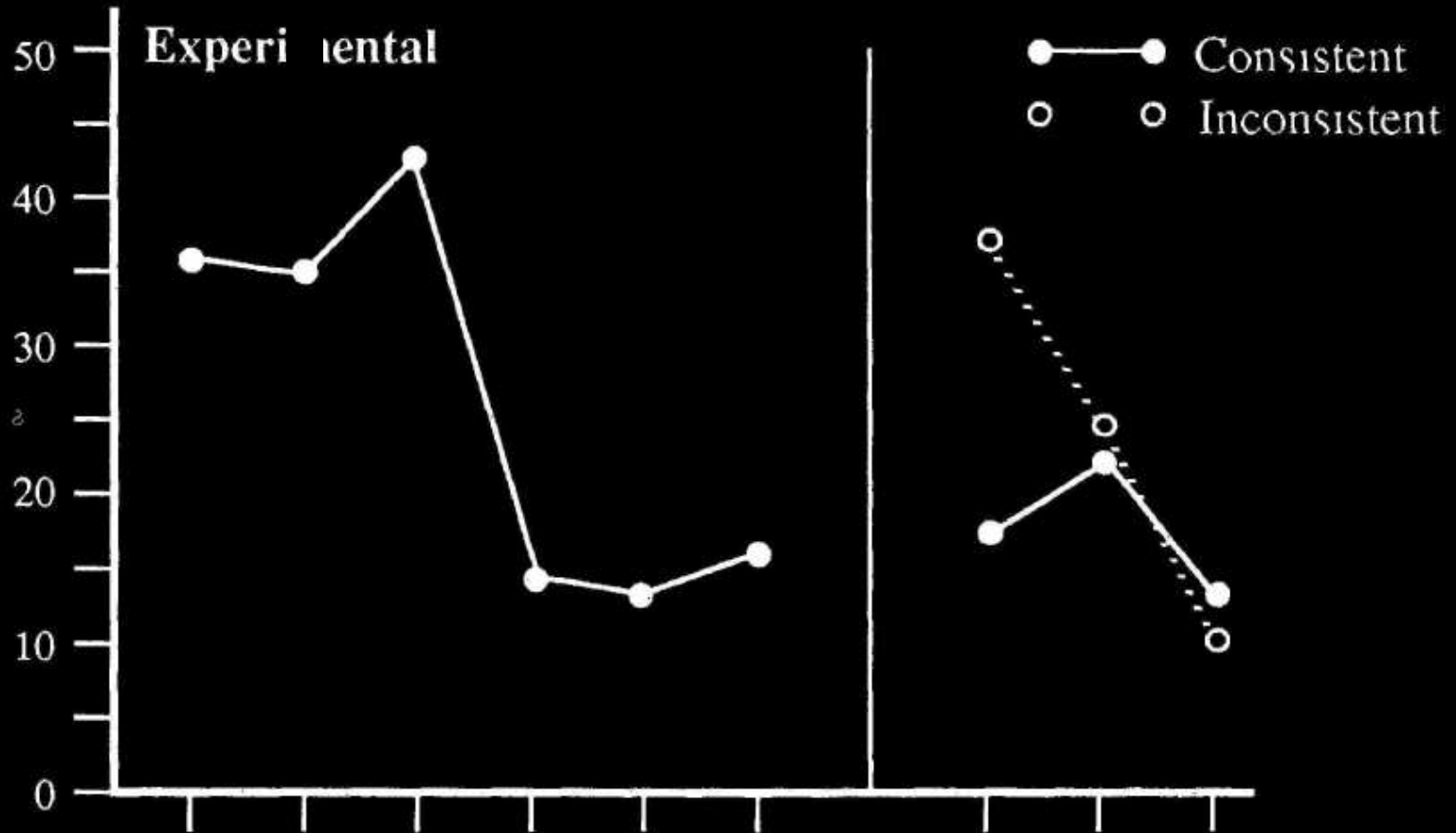
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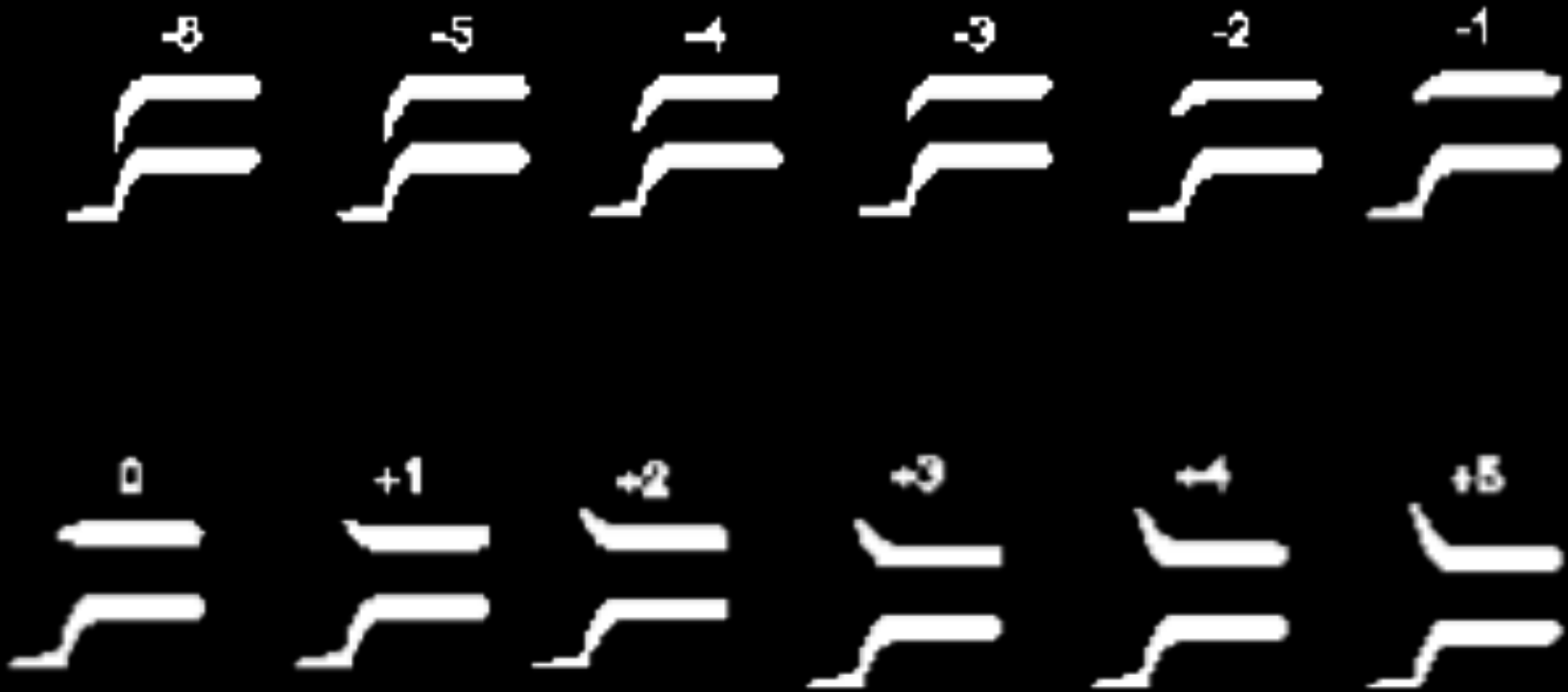
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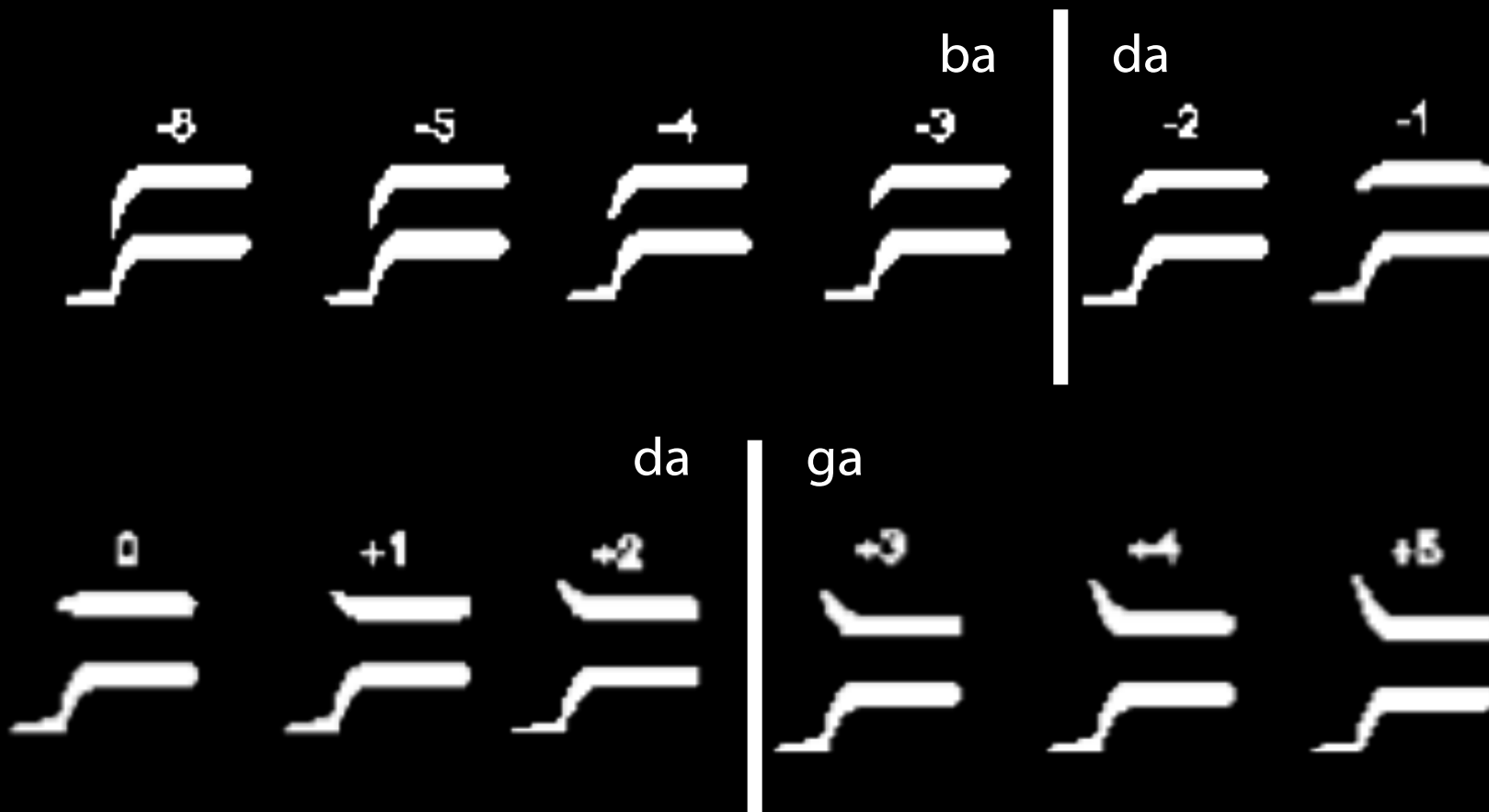
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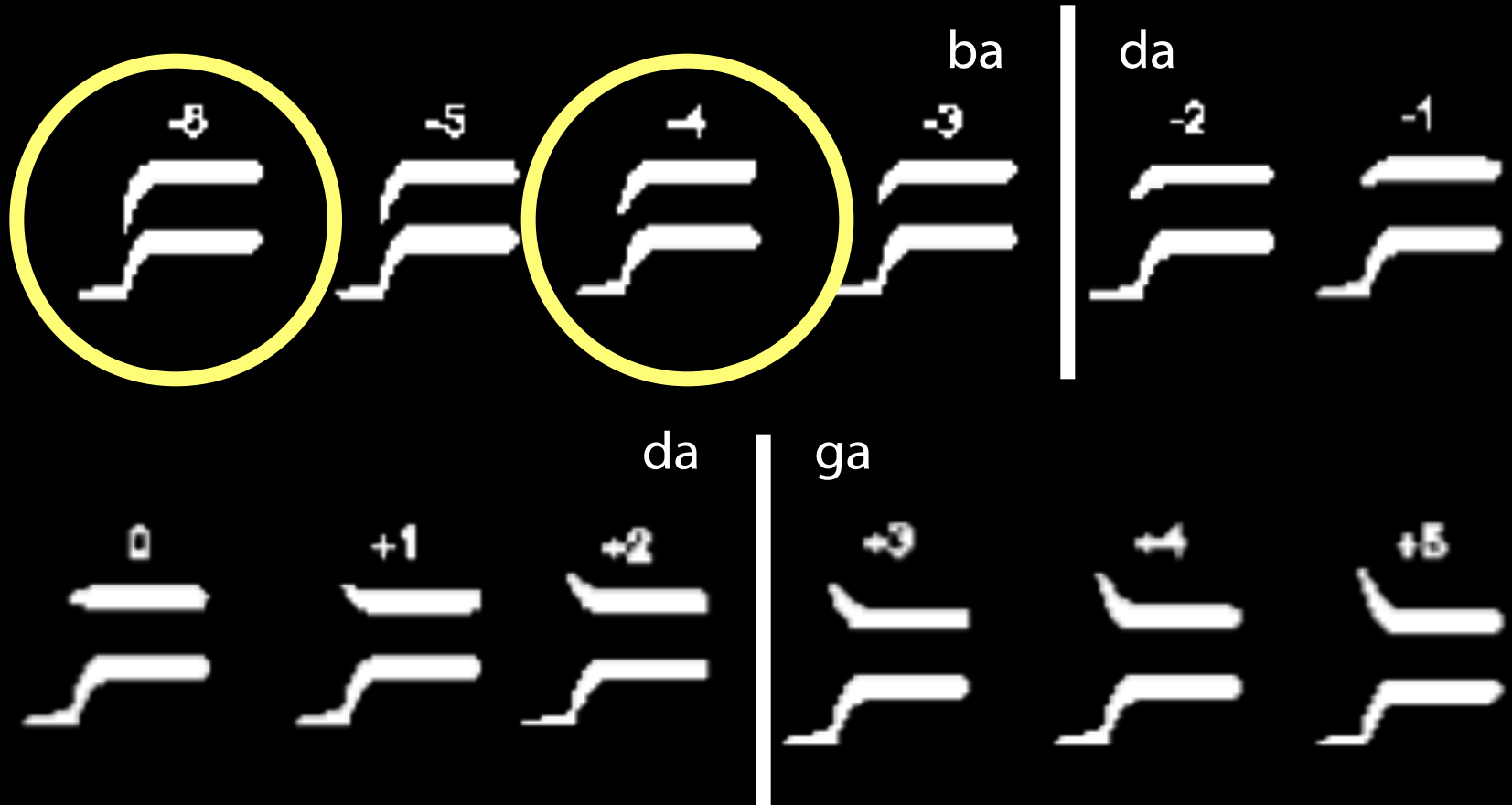
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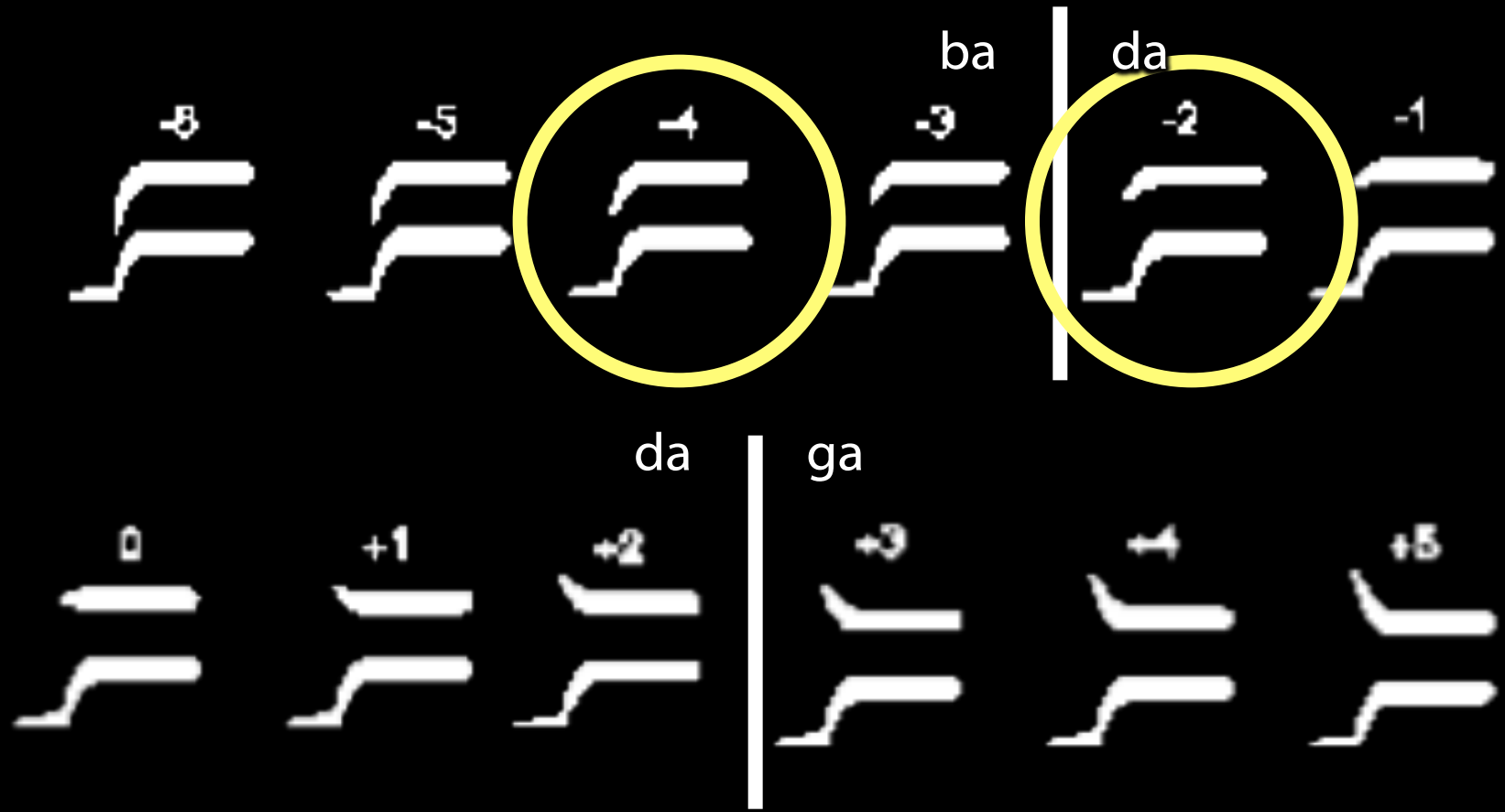
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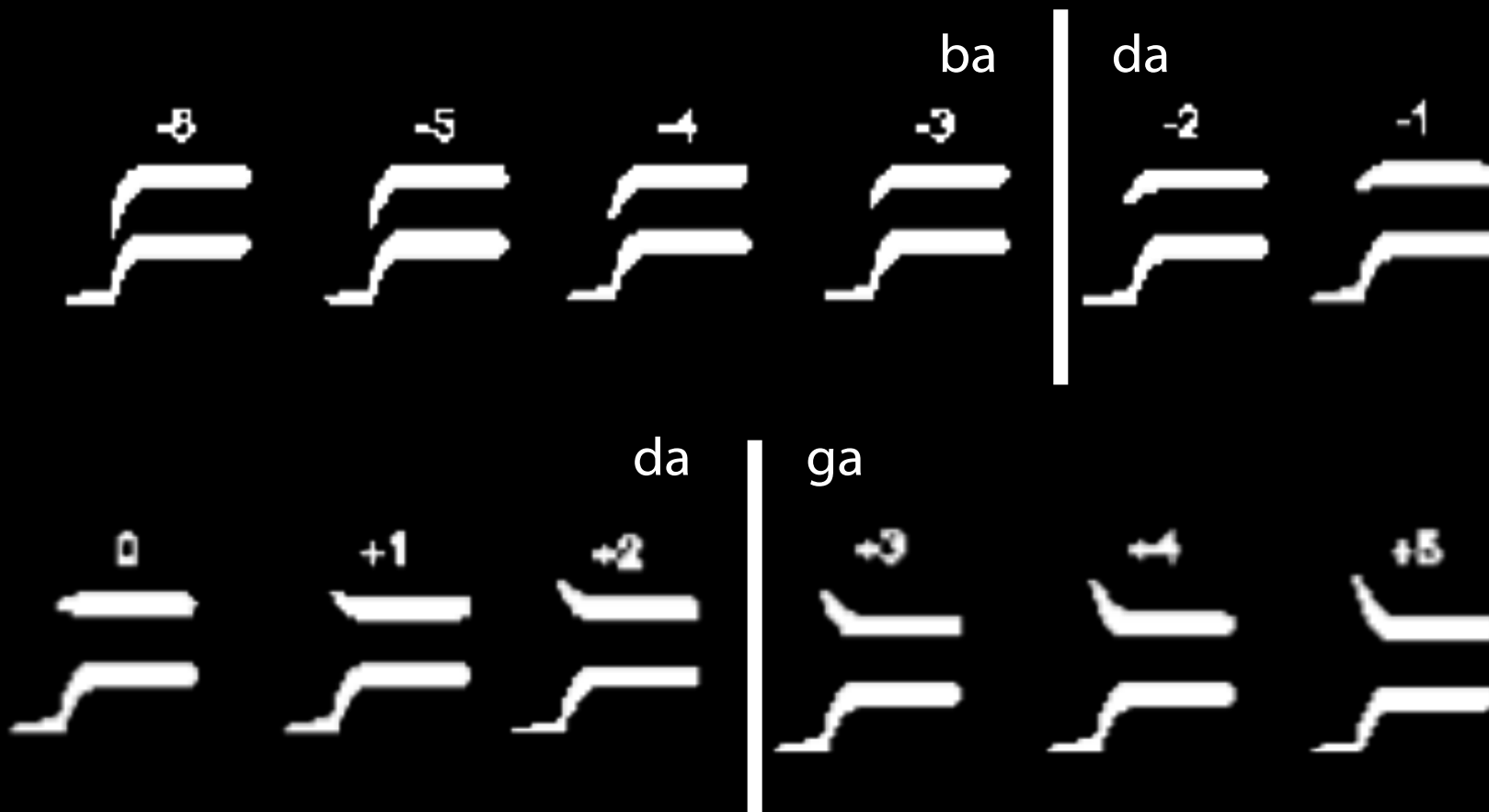
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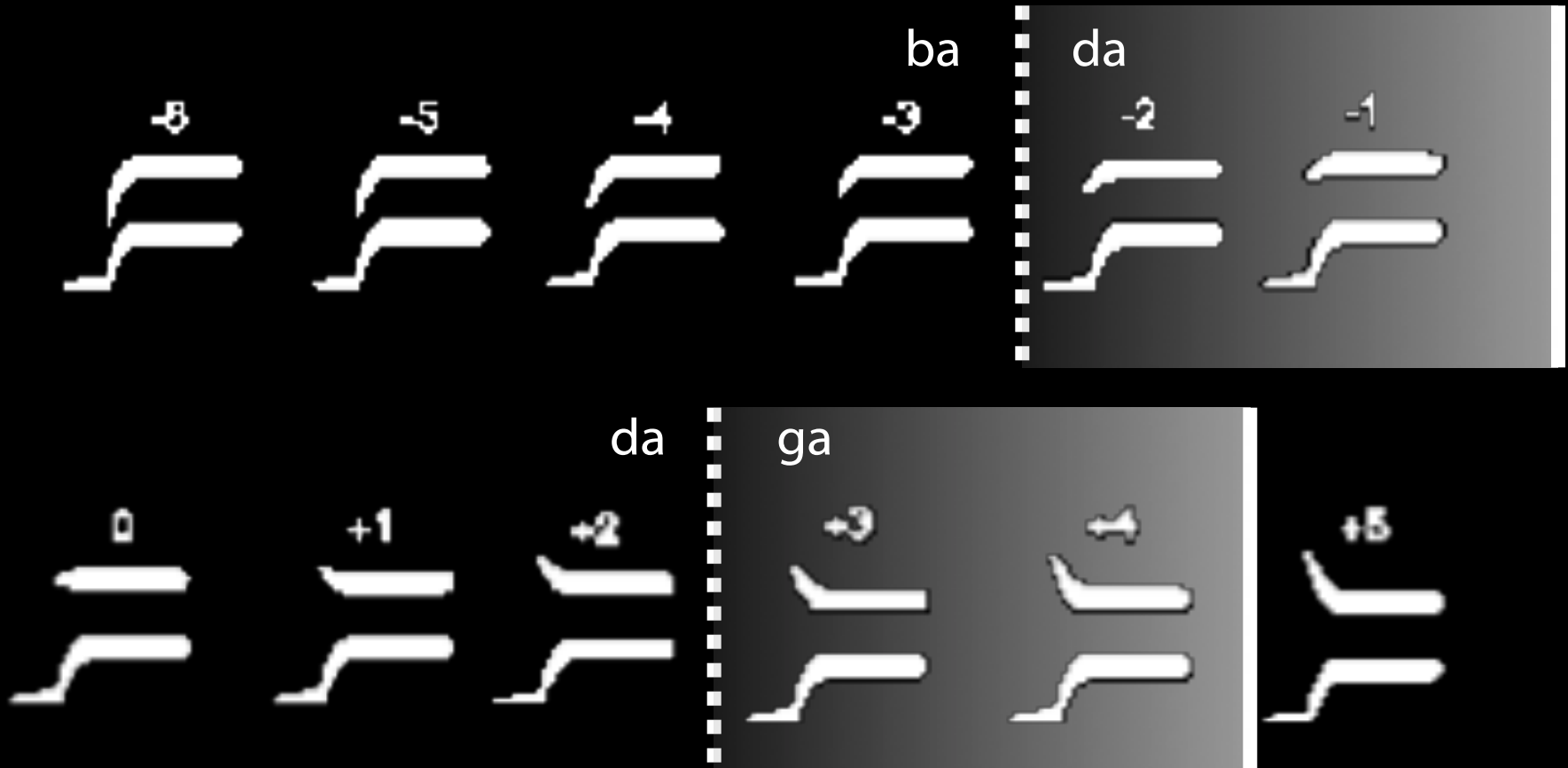
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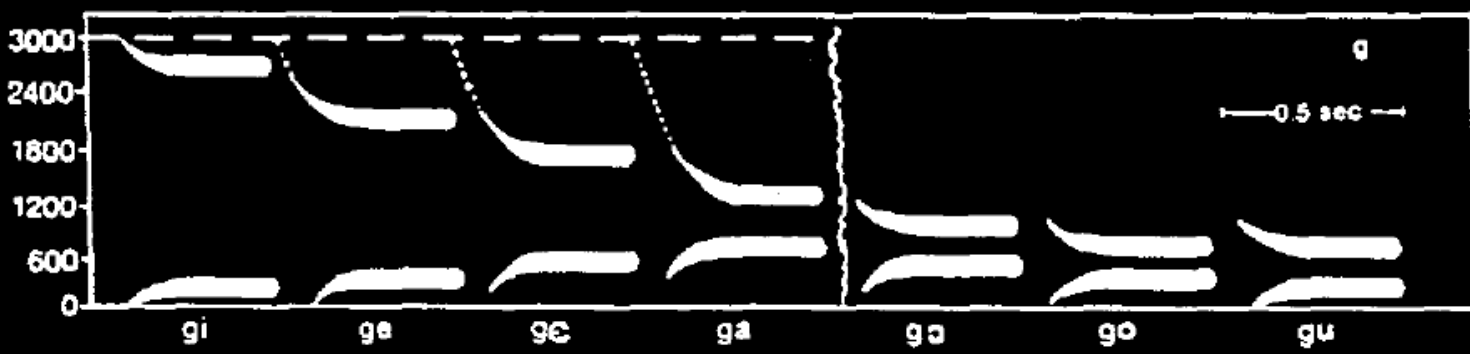
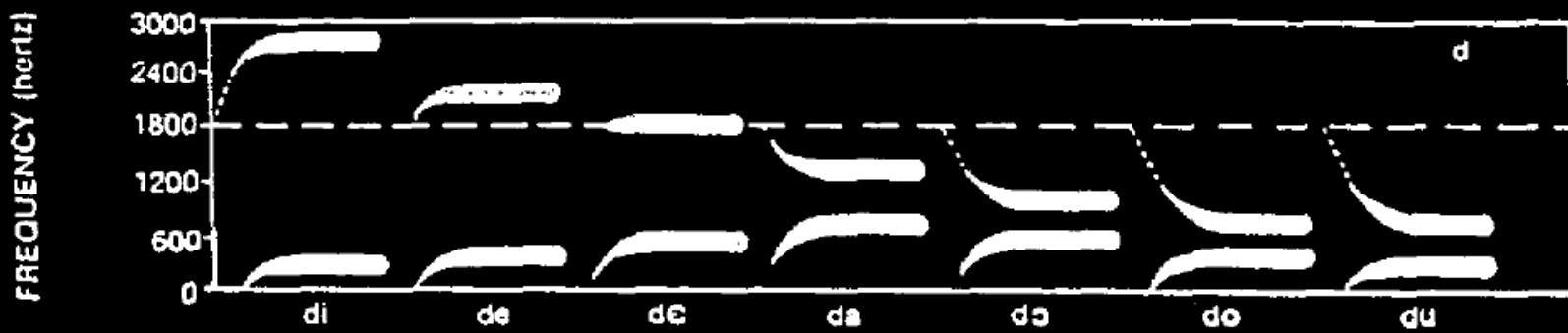
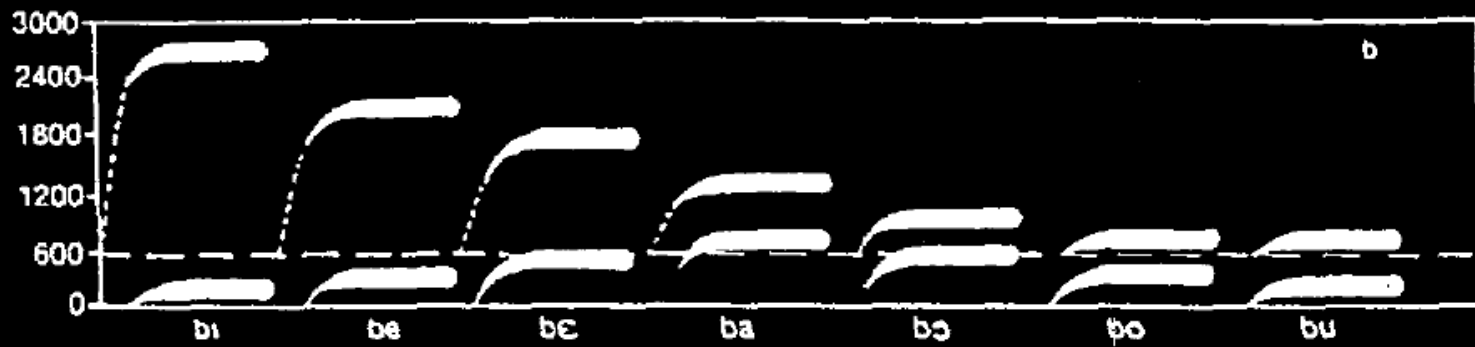


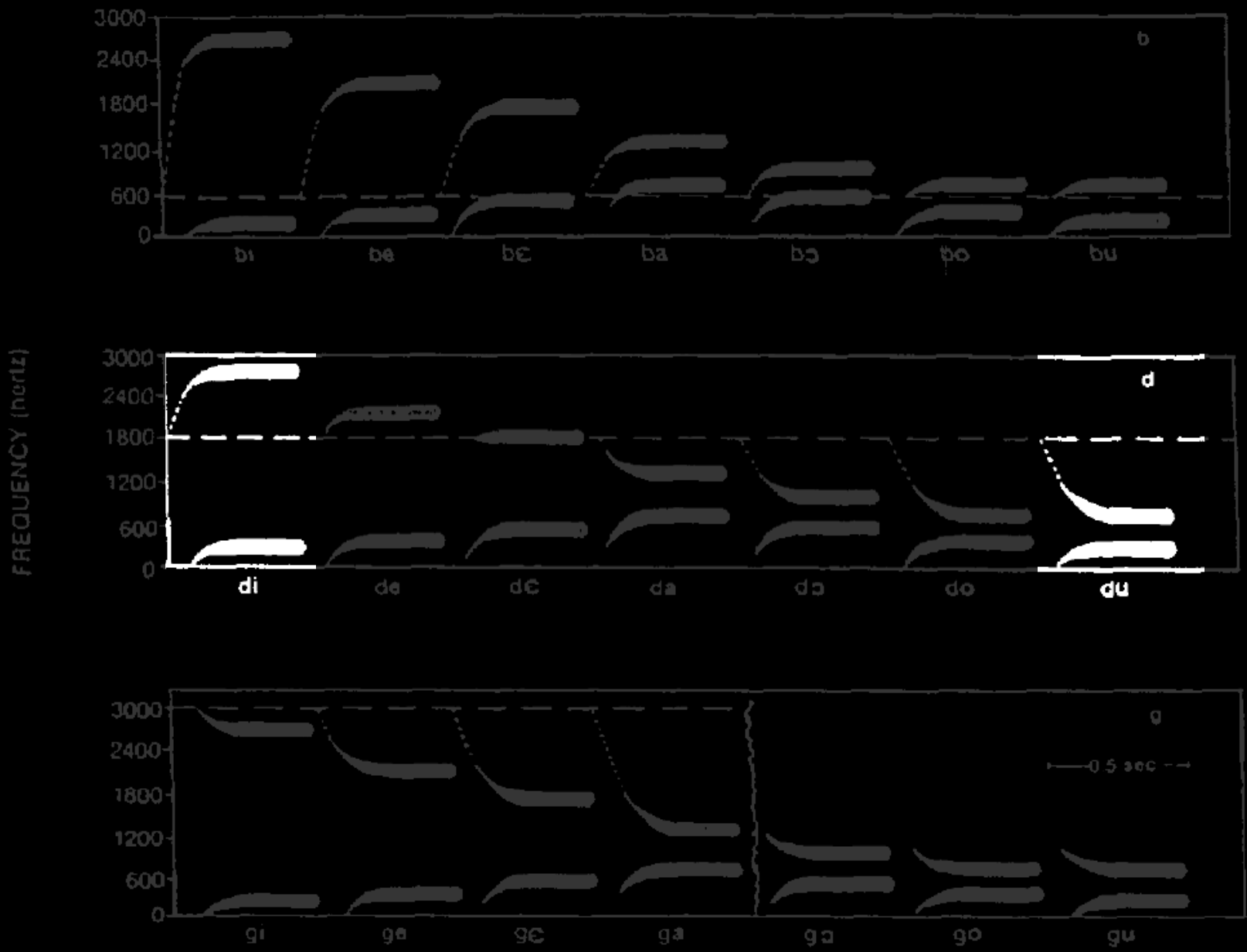
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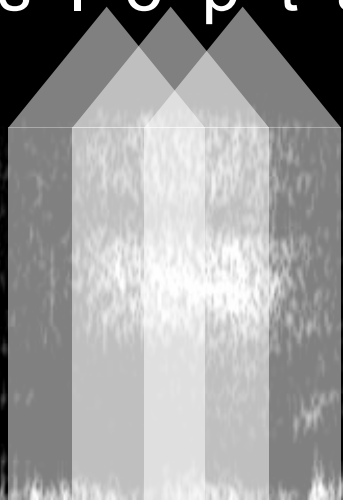
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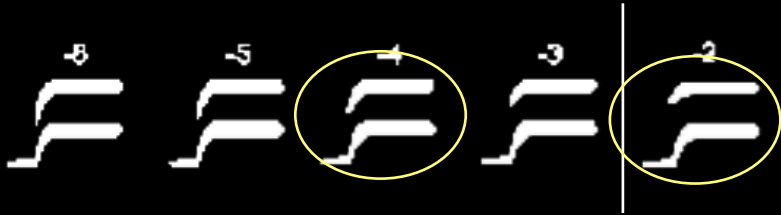




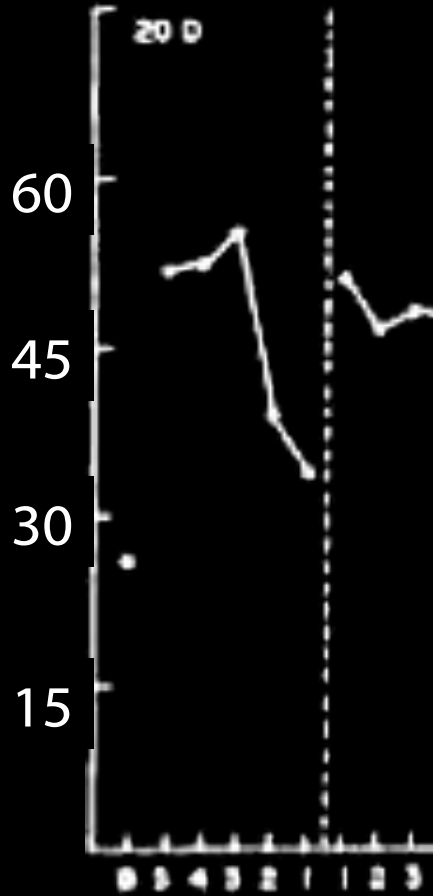


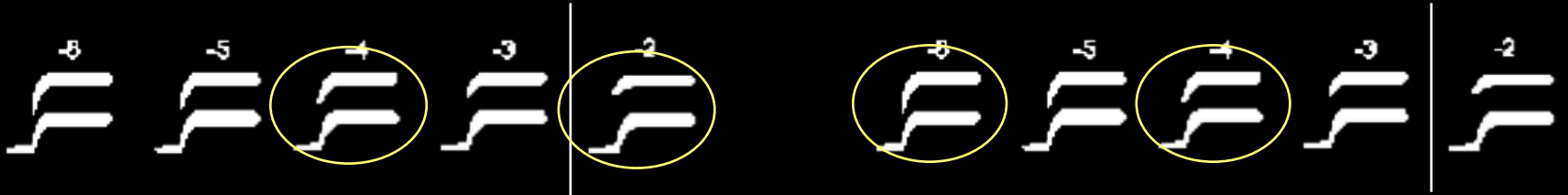
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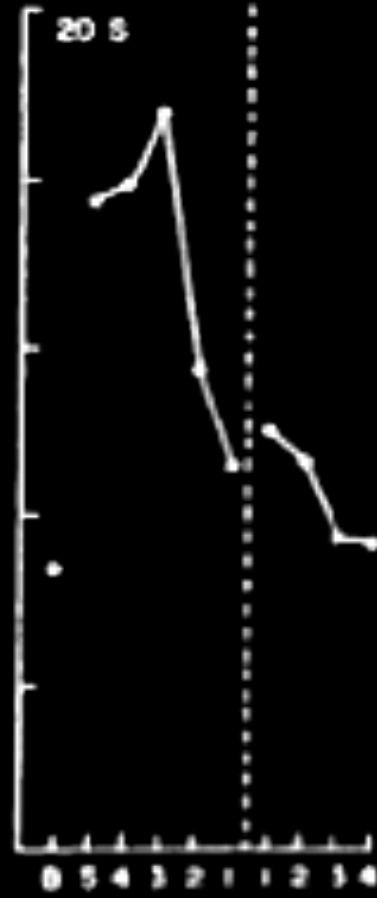
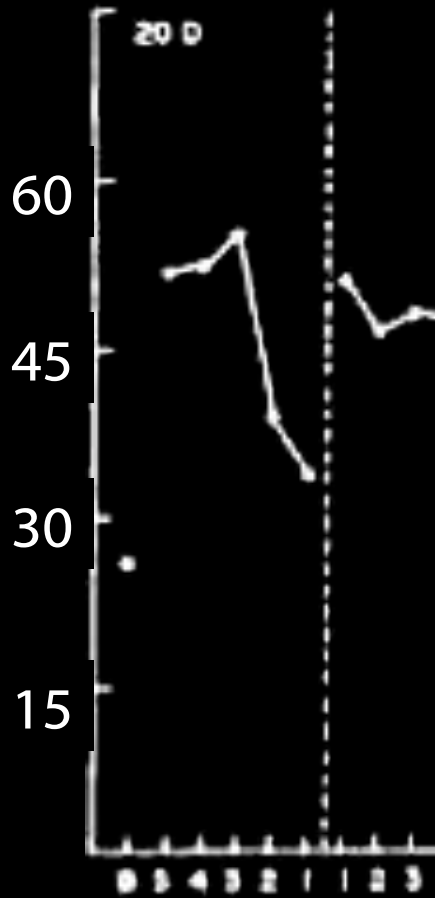


mean number of sucking
responses per minute





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4 months: categorical
perception of phonemes



Tests of phonological awareness:

- sorting according to initial phoneme
- tapping once per phoneme
- phoneme segmentation
- phoneme blending
- phoneme elision
- word completion

Success on these tasks is statistically explained by a single factor

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3-4 years: phoneme
judgements



Habituation tasks: humans can represent phonetic structure from around age four months

Phonological awareness tasks: humans cannot represent phonetic structure until age 3-4 years

4 months: categorical perception of phonemes

3-4 years: phoneme judgements



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in a non-modular process

There is a problem



Modules

1. they are 'the psychological systems whose operations present the world to thought';
2. they 'constitute a natural kind'; and
3. there is 'a cluster of properties that they have in common ... [they are] domain-specific computational systems characterized by informational encapsulation, high-speed, restricted access, neural specificity, and the rest'

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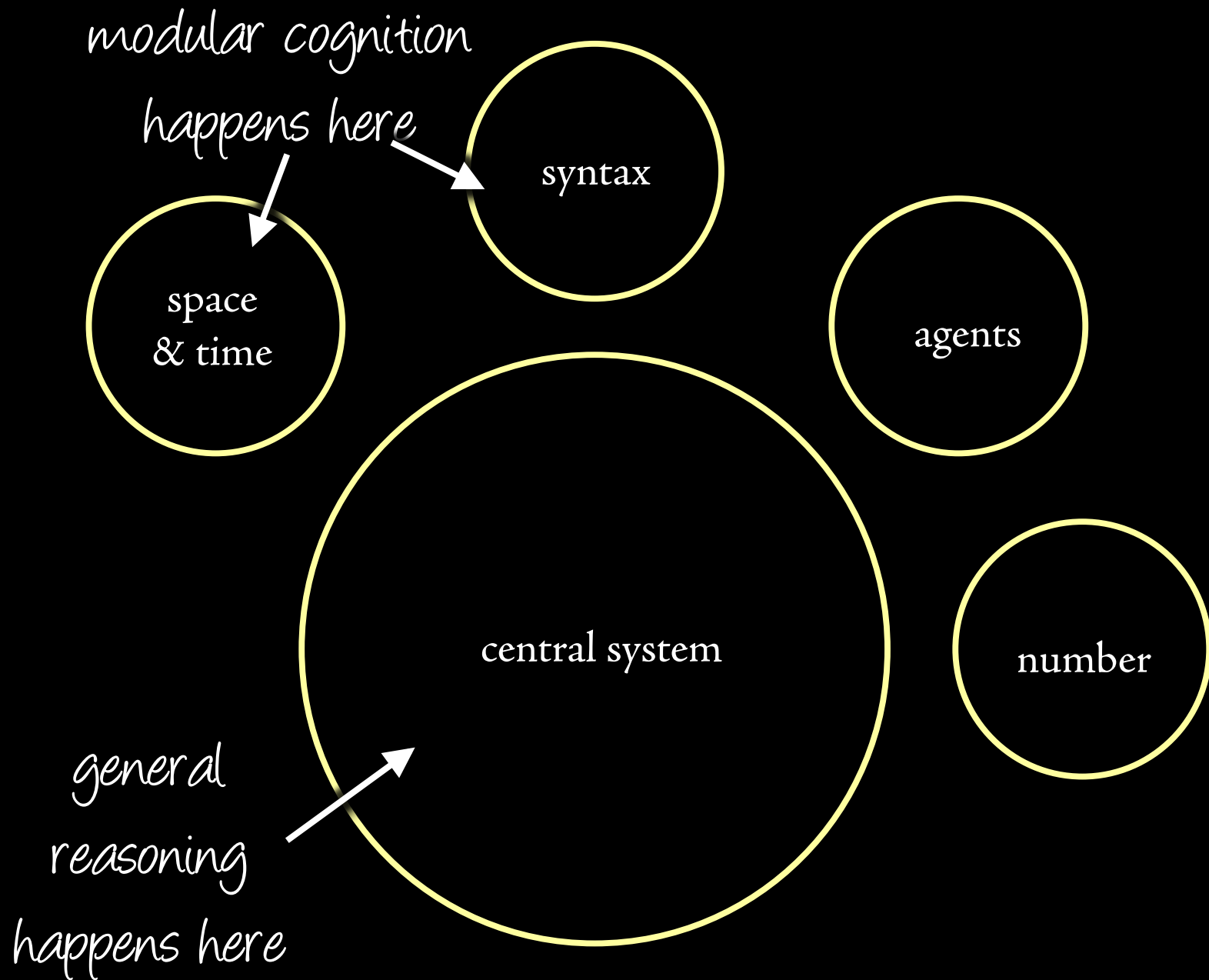


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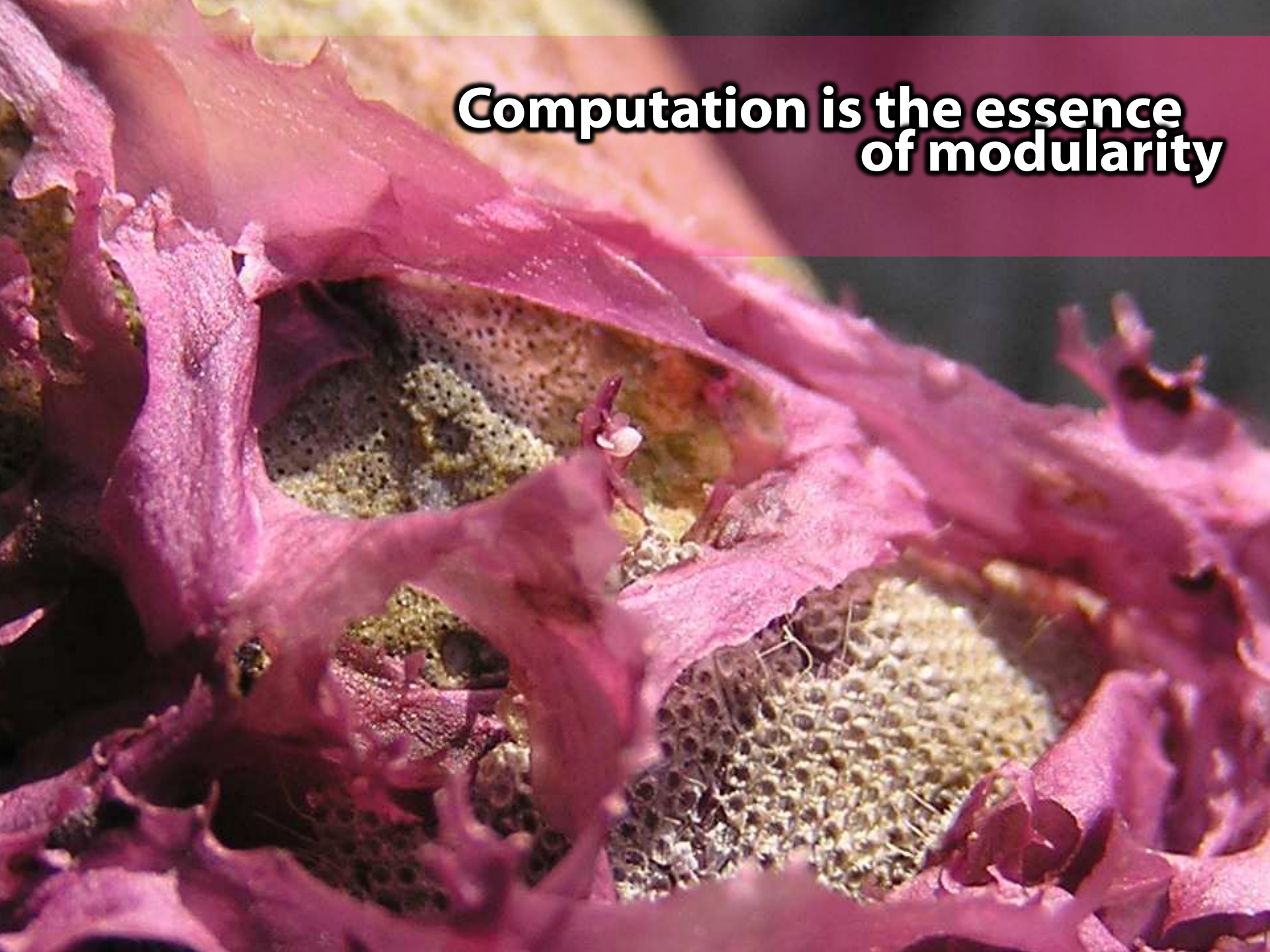
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An account of modularity has to explain why the properties associated with modules occur together

**Computation is the essence
of modularity**



The Computational Theory of the Mind



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- (b) have a systematic effect on thought and action; and
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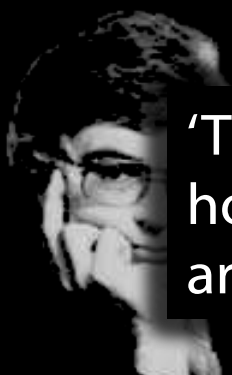


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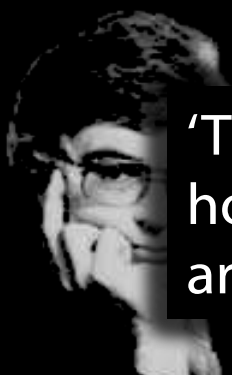
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Thought: P&Q



Representation1

Thought: Q



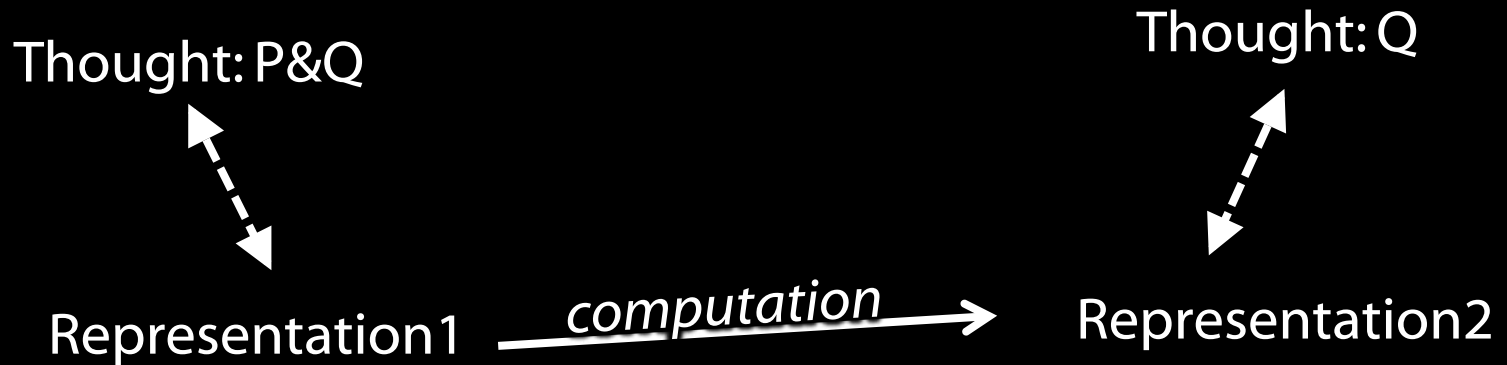
Representation2

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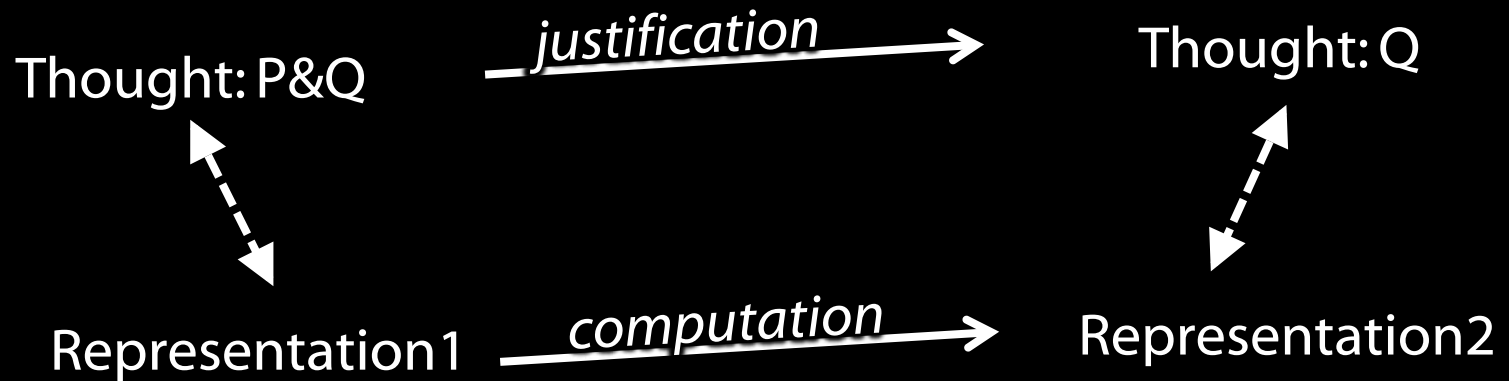


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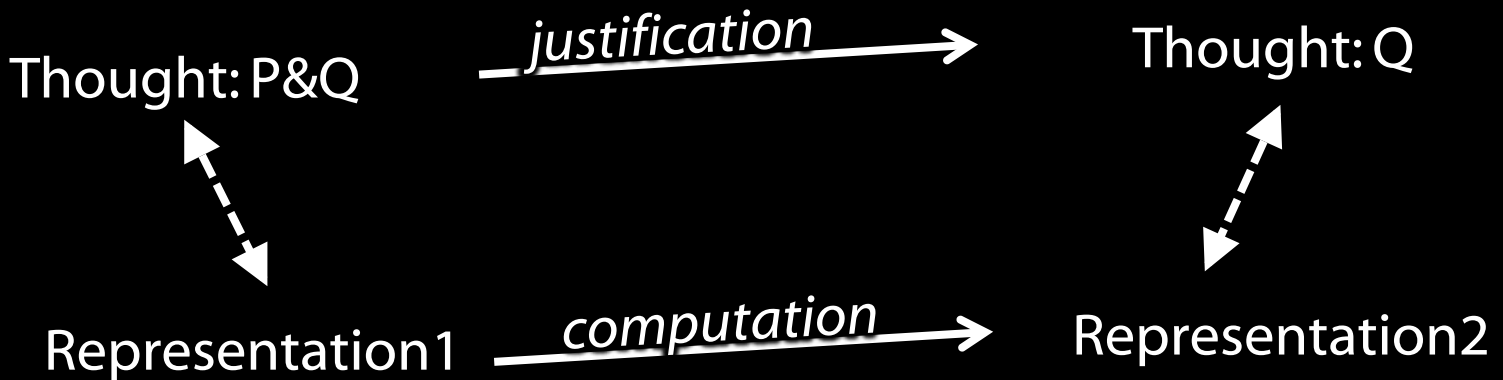


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'sooner or later, we will all have to give up on the Turing story as a general account of how the mind works'

(Fodor 2000: 47)



Fodor's (?) argument

1. Computational processes are not sensitive to context-dependent relations among representations.
2. Thinking sometimes involves being sensitive to context-dependent relations among representations as such.
3. Therefore, not all thinking is computation.

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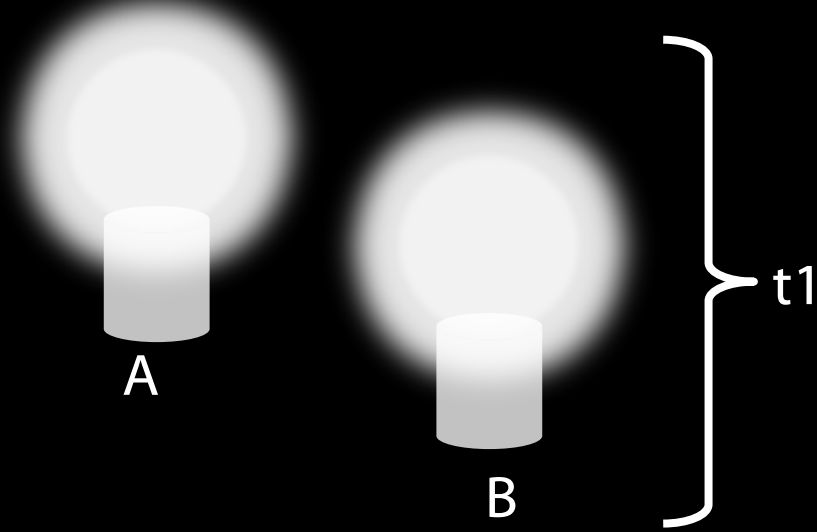
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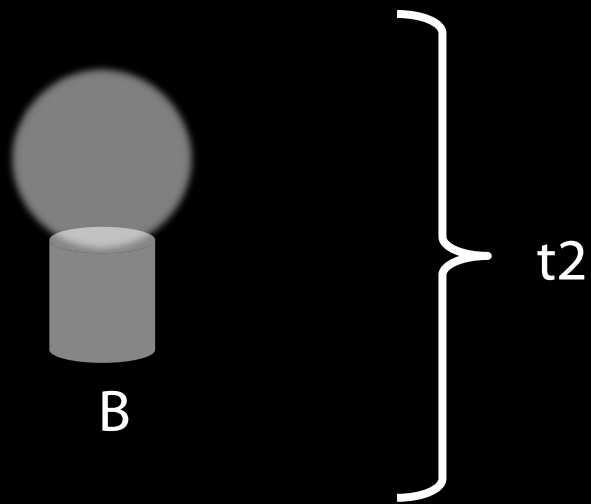
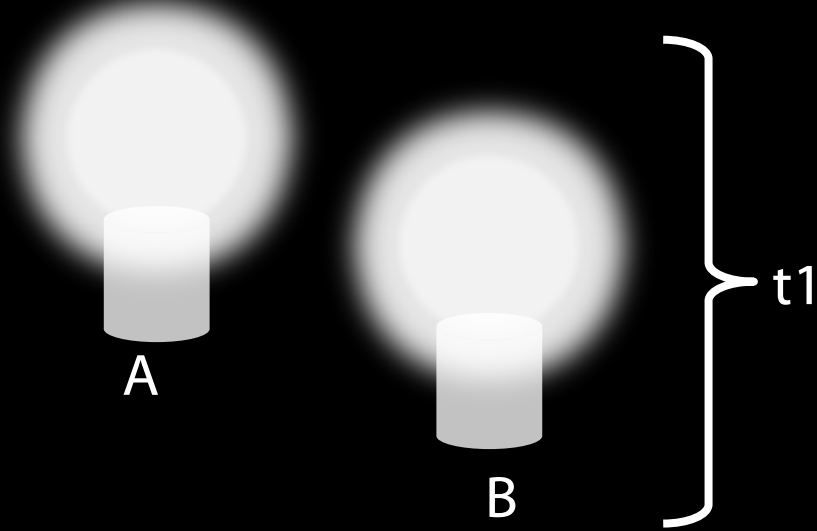
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'the Computational Theory is probably true at most of only the mind's modular parts. ... a cognitive science that provides some insight into the part of the mind that isn't modular may well have to be different, root and branch'

(Fodor 2000:99)



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(Fodor 1983:71)

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**Consequences for the role
of modules in development**

How do modules facilitate development?

(1) Role of modules ...

Modules provide 'a basic infrastructure for knowledge and its acquisition'

(Wellman and Gelman 1998:524)

How do modules facilitate development?

(1) Role of modules ...

Modules provide 'a basic infrastructure for knowledge and its acquisition'

(Wellman and Gelman 1998:524)

(2) How modules fulfil this role ...

'The module ... automatically provides a *conceptual identification* of its input for central thought ... in exactly the right format for inferential processes'

(Leslie 1988:193–4 my italics).

What are concepts?

The concept OBJECT is ...

- (a) that in virtue of having which we are able to reason about objects as such;
- (b) that in virtue of having which we are able to compute information about objects as such.

How do modules facilitate development?

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associative
process



physiological
change

sensory
experience

thought
process

The role of modules in development can be explained without appeal to direct representational links between modules and thought.

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Modular cognition ...

- * results in eye movements
- * directs attention
- * provides categorical perception

Summary so far

Theme: the role of modules in development

- (1) several views assume that there are direct representational relations between modules and thought;
- (2) this assumption is implausible if modular cognition and thinking are different kinds of process
- (3) there is an alternative



Perceiving & thinking about speech

Liberman and Mattingly's motor theory of speech perception

- * speech perception is modular
- * speech perception is categorical
- * the objects of speech perception are intended phonic gestures

How does modular cognition of speech interface with general reasoning? Does it provide conceptual identifications of phonemes?

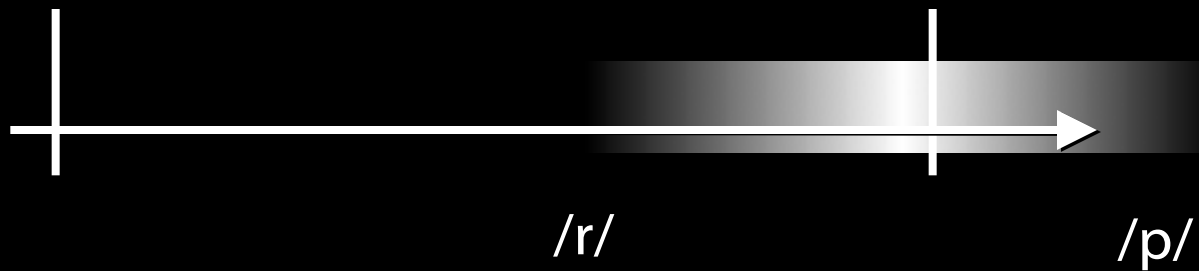
4 months: categorical
perception of phonemes

3-4 years: phoneme
judgements



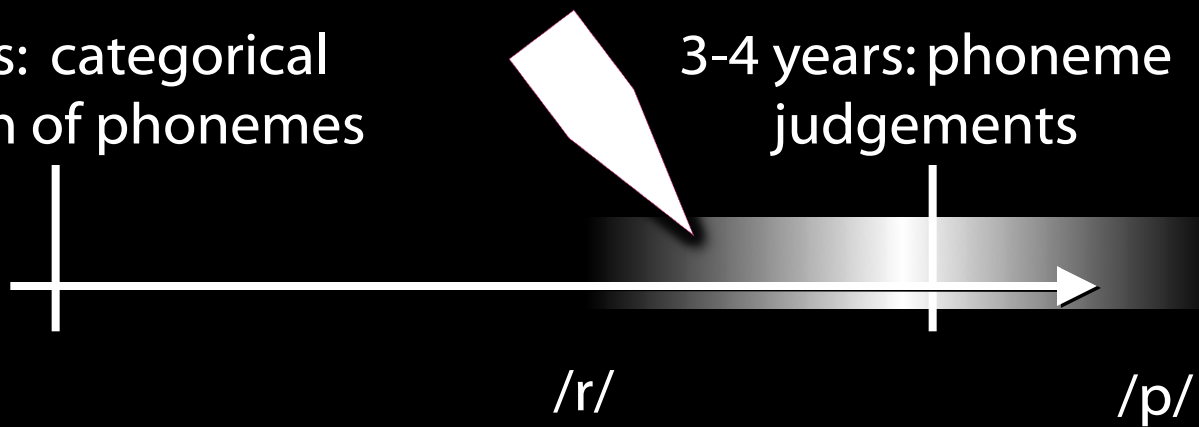
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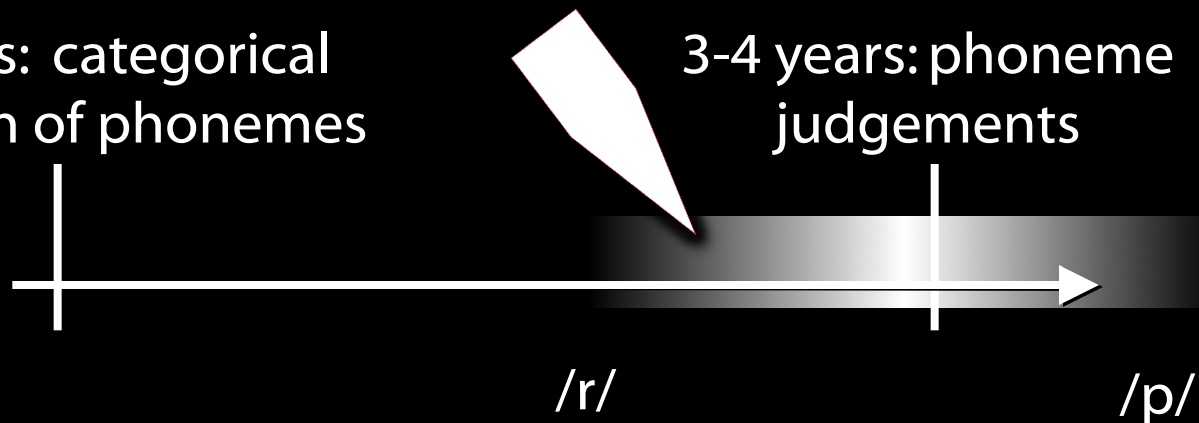


'we believe that children's performance depends on cognitive capacities that are continuous over human development'

(Spelke 2001:336)

4 months: categorical perception of phonemes

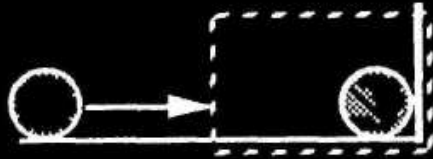
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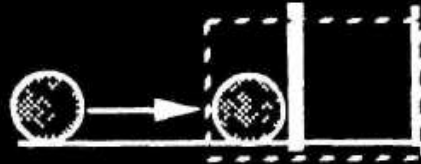
Summary so far

- * The speech module supports categorical perception of phonemes
- * Categorical perception is not conceptual identification
- * This explains the 3-4 year gap between perception and conception of phonemes.

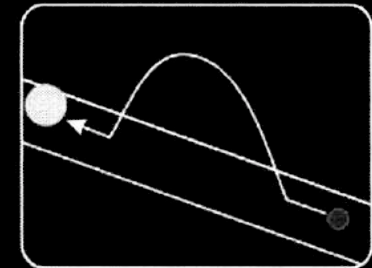
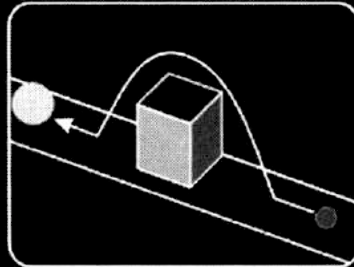
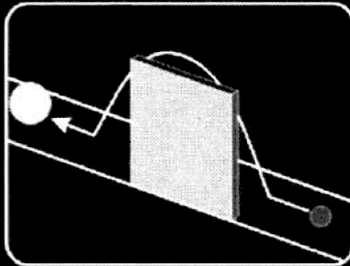
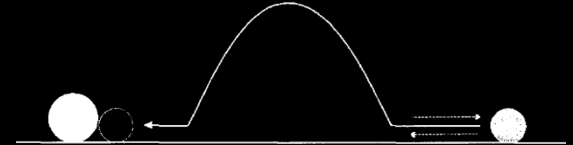
habituation



consistent



inconsistent



Conclusion



Conclusions

1. If modules exist, there is more to modularity than a cluster of features.
2. Modular cognition differs from thinking in being a different kind of process; specifically, in being a special kind of computational process.
3. The 'concepts' and 'knowledge' involved in modular cognition differ in kind from those involved in general reasoning.
4. The relation between modular cognition and general reasoning is indirect.
5. Categorical perception of speech provides a model of non-representational communication between modules and thought

Nativism about knowledge

Not all knowledge is acquired by learning

Poverty of Stimulus Argument

- (1) Experience alone wouldn't enable us to know truths about X.
- (2) But we do know truths about X.

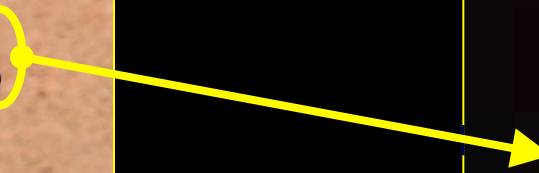
Therefore:

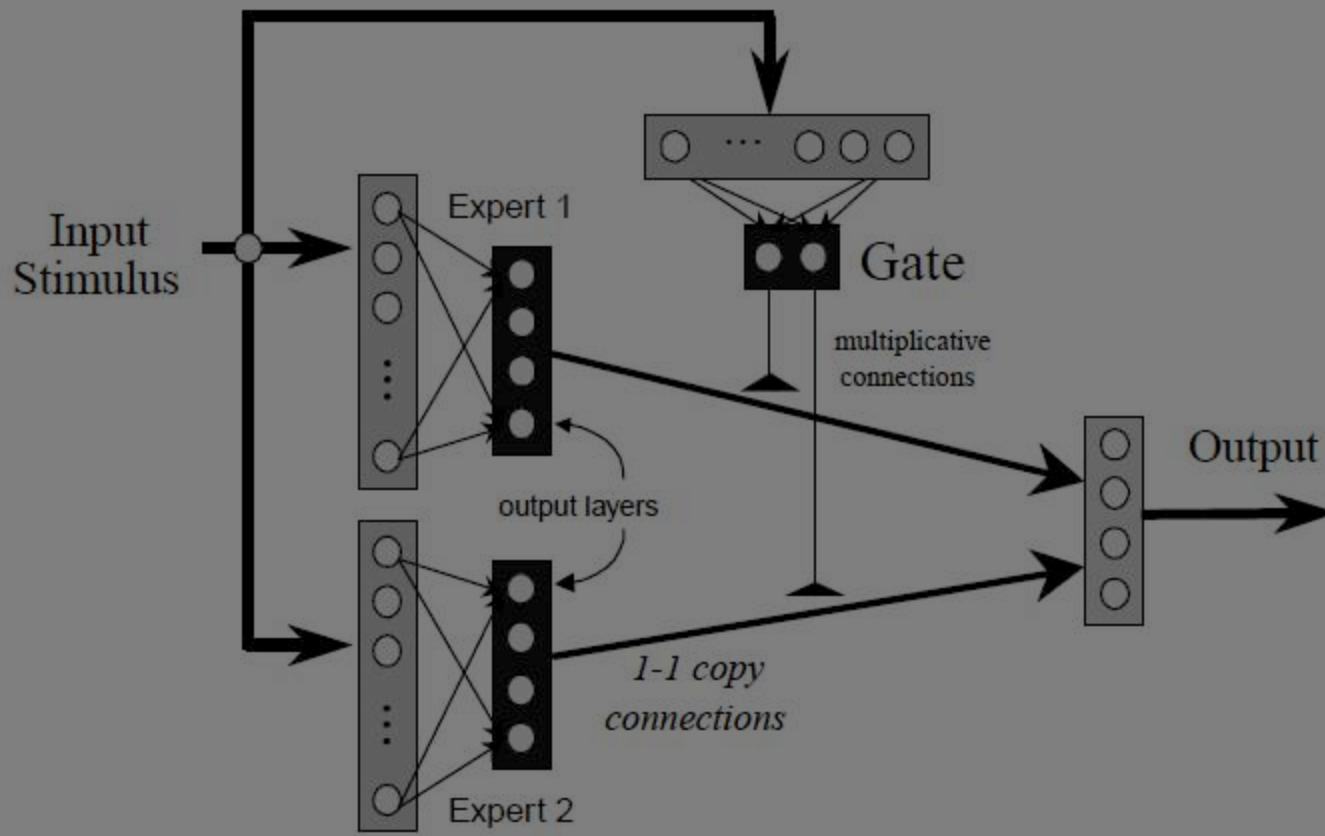
- (3) Some knowledge about X must be innate.

The Problem of Truth

Knowledge involves true beliefs and it's hard to see how beliefs could be true unless acquired through learning.







(a)

Dailey and Cotrell (1999), figure 2

'Specialized cognitive mechanisms can allow attention to go to specific properties or sets of properties. ... this general idea can be extended to non-sensory concepts, and even to highly abstract concepts. For example, the 'Michotte module' allows young infants to attend to causes and effects, grounding the concept 'cause' without infants knowing anything about what causes really are (Leslie & Keeble, 1987). But **once the child can selectively attend to the property in question, the child can have thoughts about that property**, make observations about that property and, most importantly, can begin to learn things about that property'

(Gelman and Leslie 2001:61)

Core systems are 'structures ... just as specific as those that underlie animal cognition, human perception, and human action. Just as humans are endowed with multiple, specialized perceptual systems, so we are endowed with multiple systems for representing and reasoning about entities of different kinds.'

(Carey and Spelke 1996:517)

'core systems are conceptual and provide a foundation for the growth of knowledge. ... core systems are largely innate, encapsulated, and unchanging, arising from phylogenetically old systems built upon the output of innate perceptual analyzers.'

(Carey and Spelke 1996:520)



- * **domain specificity**
modules deal with 'eccentric' bodies of facts
- * **limited accessibility**
representations in modules are not usually inferentially integrated with general knowledge
- * **information encapsulation**
modules are unaffected by general knowledge or representations in other modules, i.e. 'top down' processing is limited
- * **innateness**
the representations and operations of a module are genetically specified



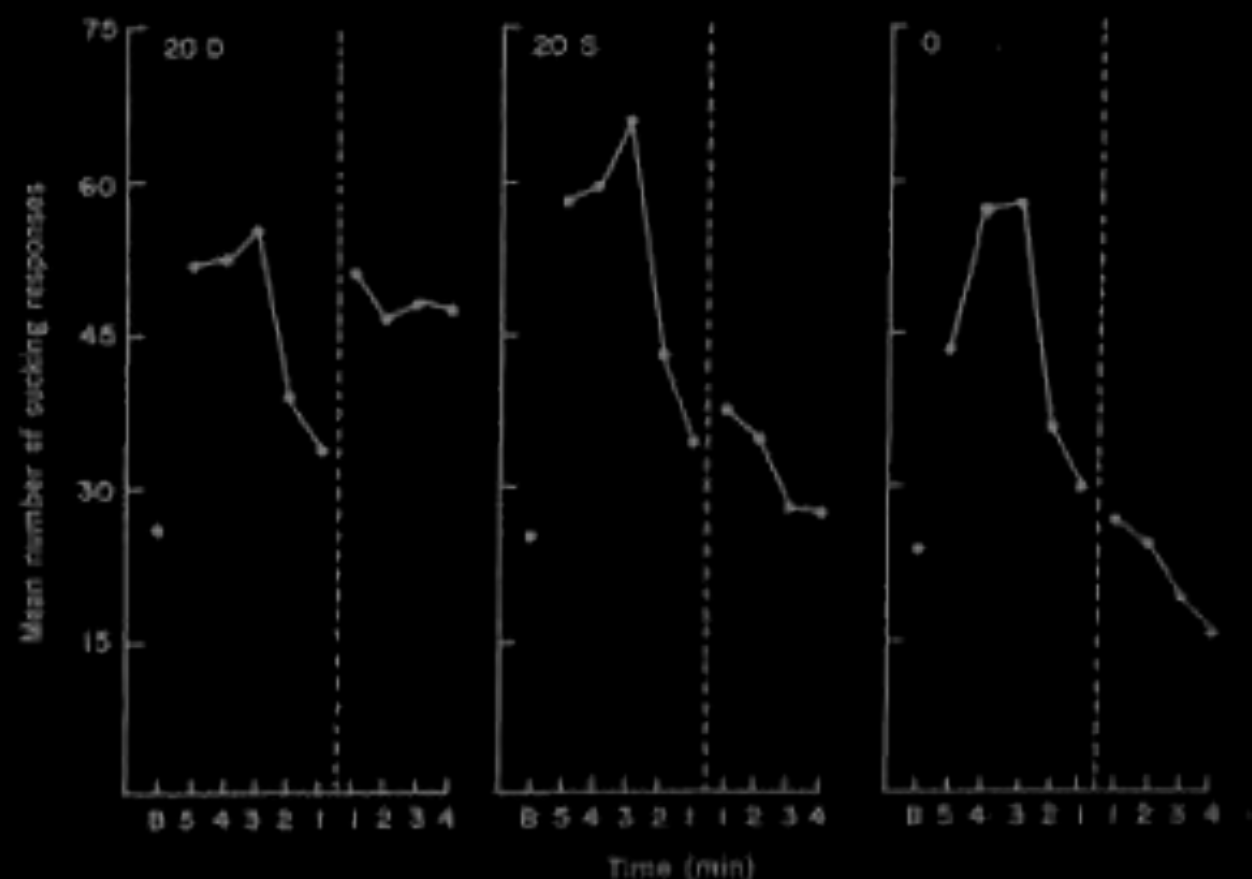


Fig. 2. Mean number of sucking responses for the 4-month-old infants, as a function of time and experimental condition. The dashed line indicates the occurrence of the stimulus shift, or in the case of the control group the time at which the shift would have occurred. The letter *B* stands for the baseline rate. Time is measured with reference to the moment of stimulus shift and indicates the 5 minutes prior to and the 4 minutes after shift.

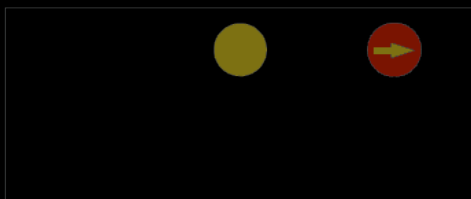
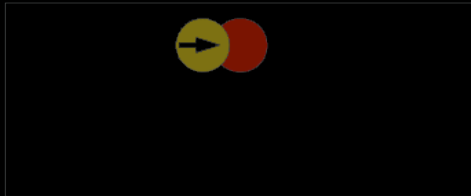
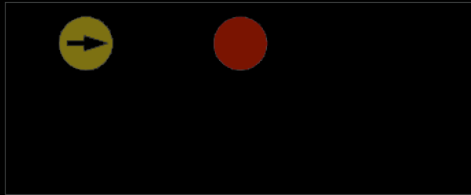
agency, analogical
reasoning, ...

10 months: perception
of launchings

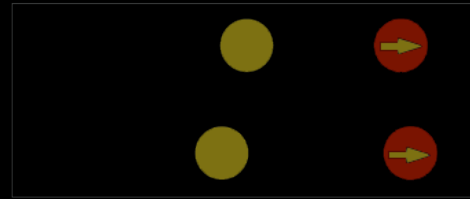
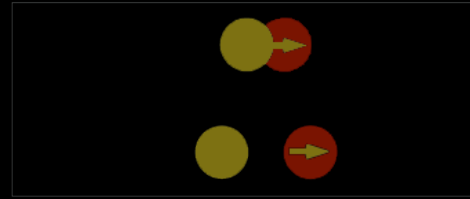
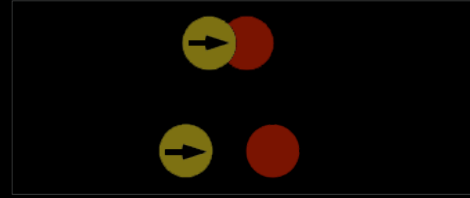
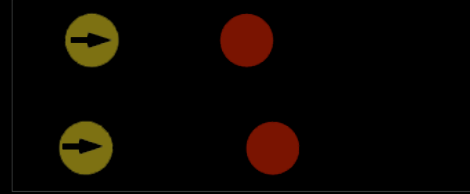
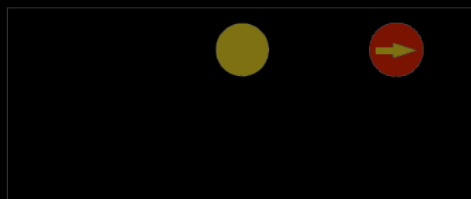
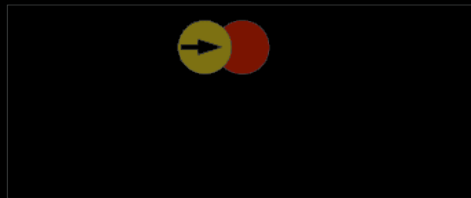
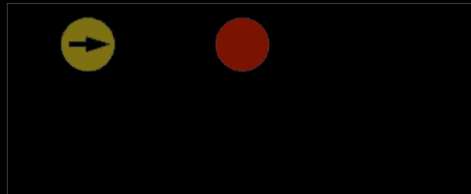
2-4 years: causal
concepts



Scholl and Nakayama's illusory causal crescents

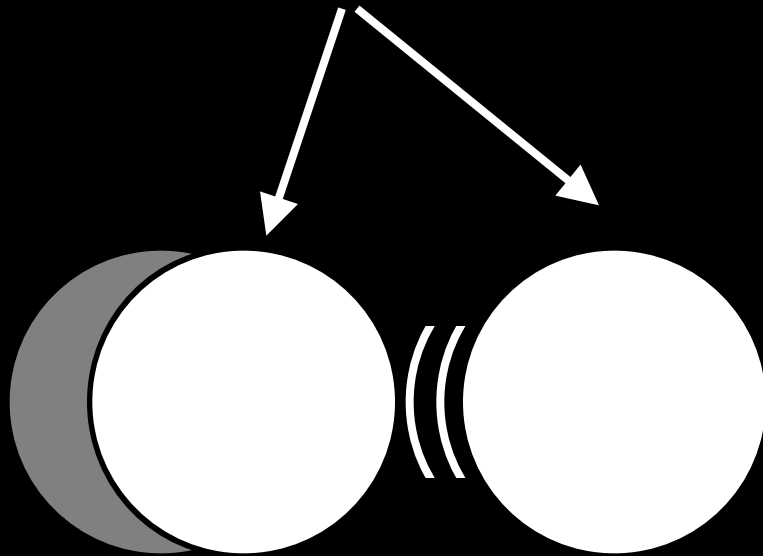


Scholl and Nakayama's illusory causal crescents



Causal Perception Is Object Perception

distinct surfaces => different objects



continuity of motion => same object

Object-specific preview-effect (Kahneman et al 1992)

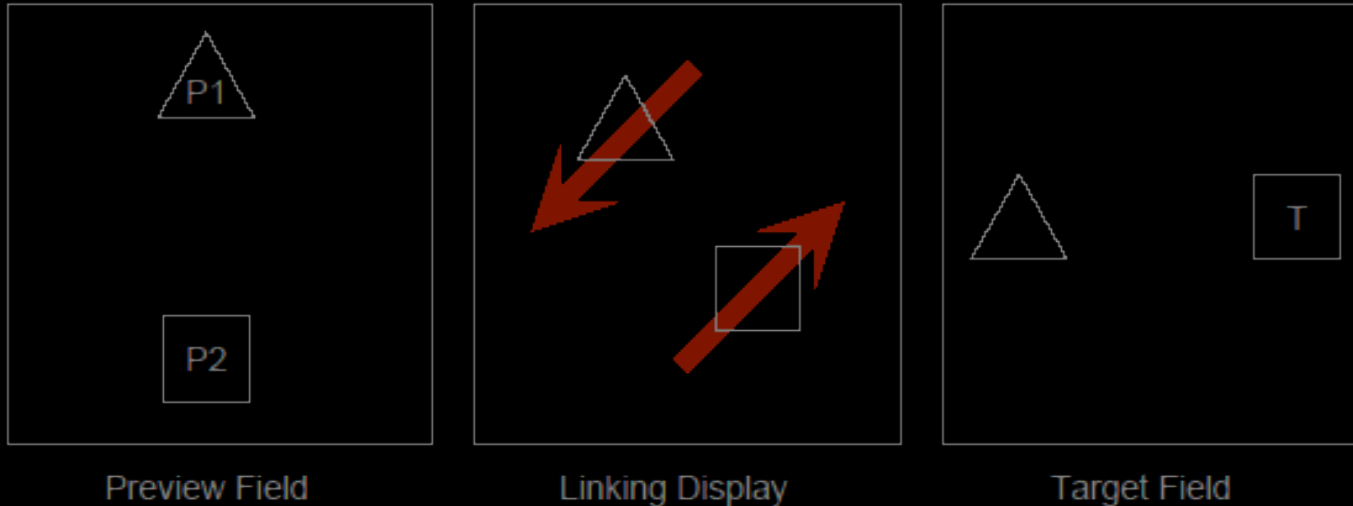
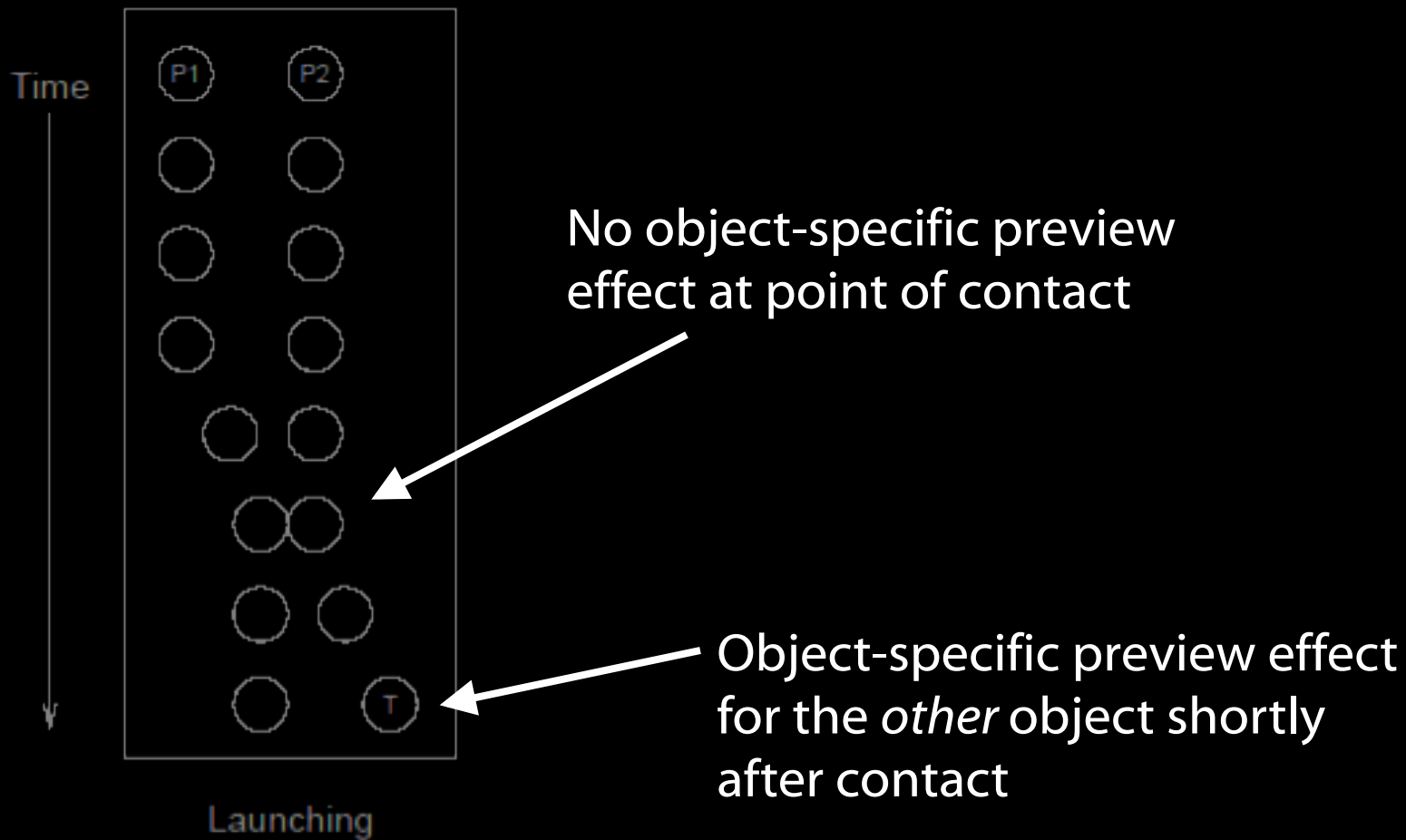


Figure 1: Example of the reviewing paradigm used by Kahneman et al. (1992).

'observers can identify target letters that matched the preview letter from the same object faster than they can identify target letters that matched the preview letter from the other object.'

(Krushke and Fragassi 1996 :2)



(from Krushke and Fragassi 1996)

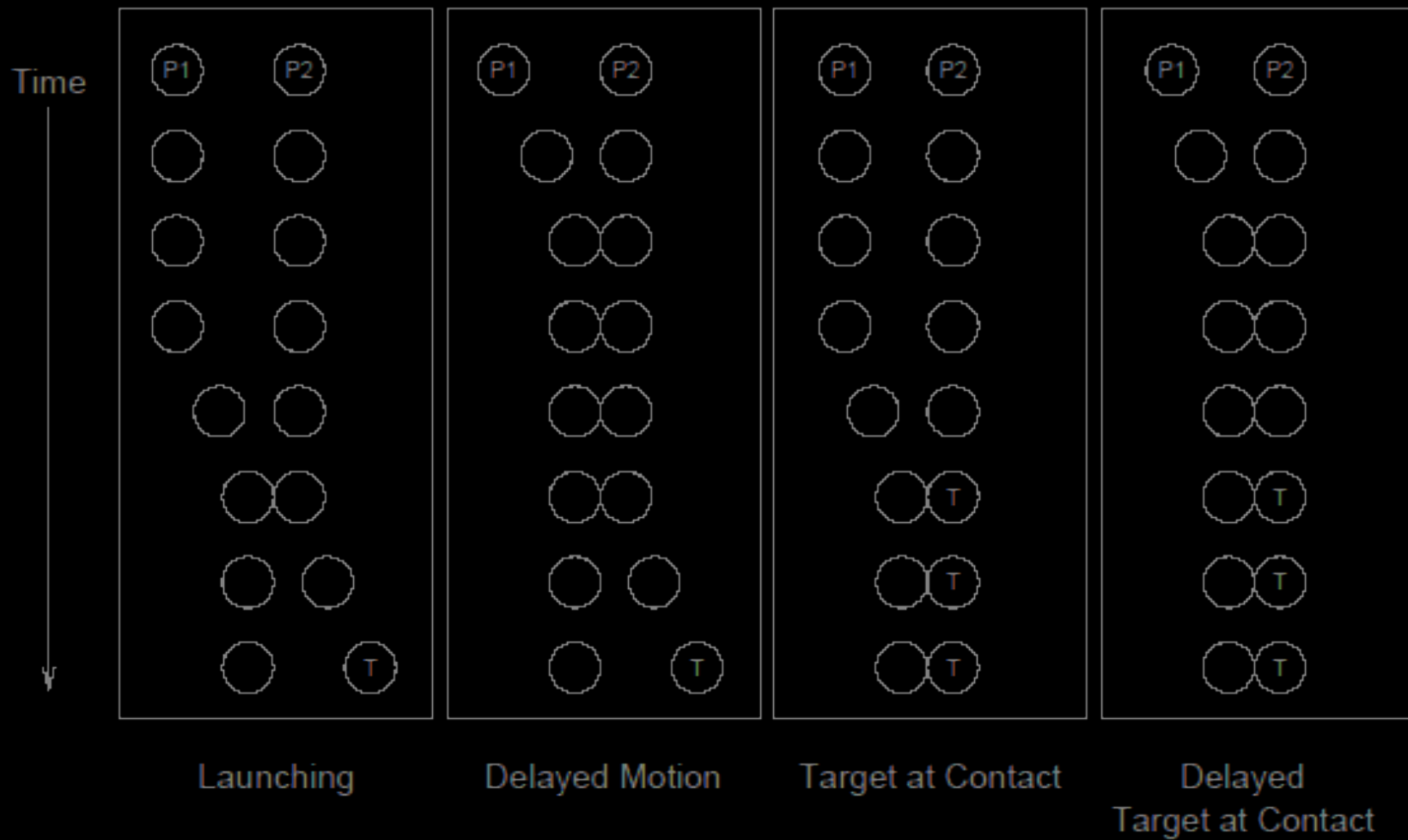


Figure 2: Schematic diagram of the four events in our experiment (not drawn to scale).

(from Krushke and Fragassi 1996)

How do modules facilitate development?

(1) Role of modules ...

Modules provide 'a basic infrastructure for knowledge and its acquisition'

(Wellman and Gelman 1998:524)

(2) How modules fulfil this role ...

'The module ... automatically provides a *conceptual identification* of its input for central thought ... in exactly the right format for inferential processes'

(Leslie 1988:193–4 my italics).

'The building blocks of all our complex representations are the representations that are constructed from individual core knowledge systems.'

(Spelke 2003:307)

Two notions of assembling ...

(a) science-like ...

'conceptual change in childhood is the same sort of process as is conceptual change in the history of science'
(Carey and Spelke 1994: 193)

(b) language-based ...

'Once they have learnt these terms ['left' and 'blue'], the combinatorial machinery of natural language allows children to formulate and understand expressions such as left of the blue wall with no further learning'

(Spelke 2003: 296)

How do modules facilitate development?

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Habituation tasks: humans can represent phonetic structure from around age four months

Phonological awareness tasks: humans cannot represent phonetic structure until age 3-4 years

'it does not follow from the fact that a child can easily distinguish *bud* from *bat* that he can therefore respond analytically to the phonemic structure that underlies the distinction'

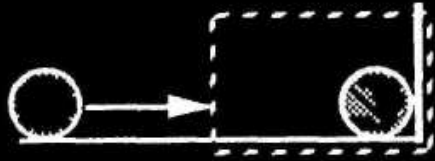
(I. Liberman, Shankweiler, et al. 1974: 203).

4 months: categorical
perception of phonemes

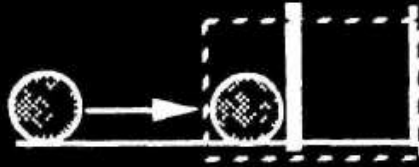
3-4 years: phoneme
judgements



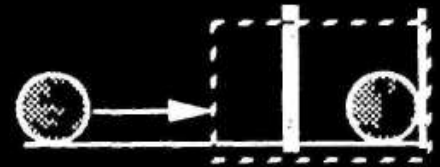
habituation



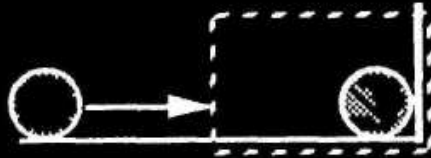
consistent



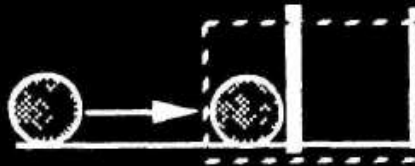
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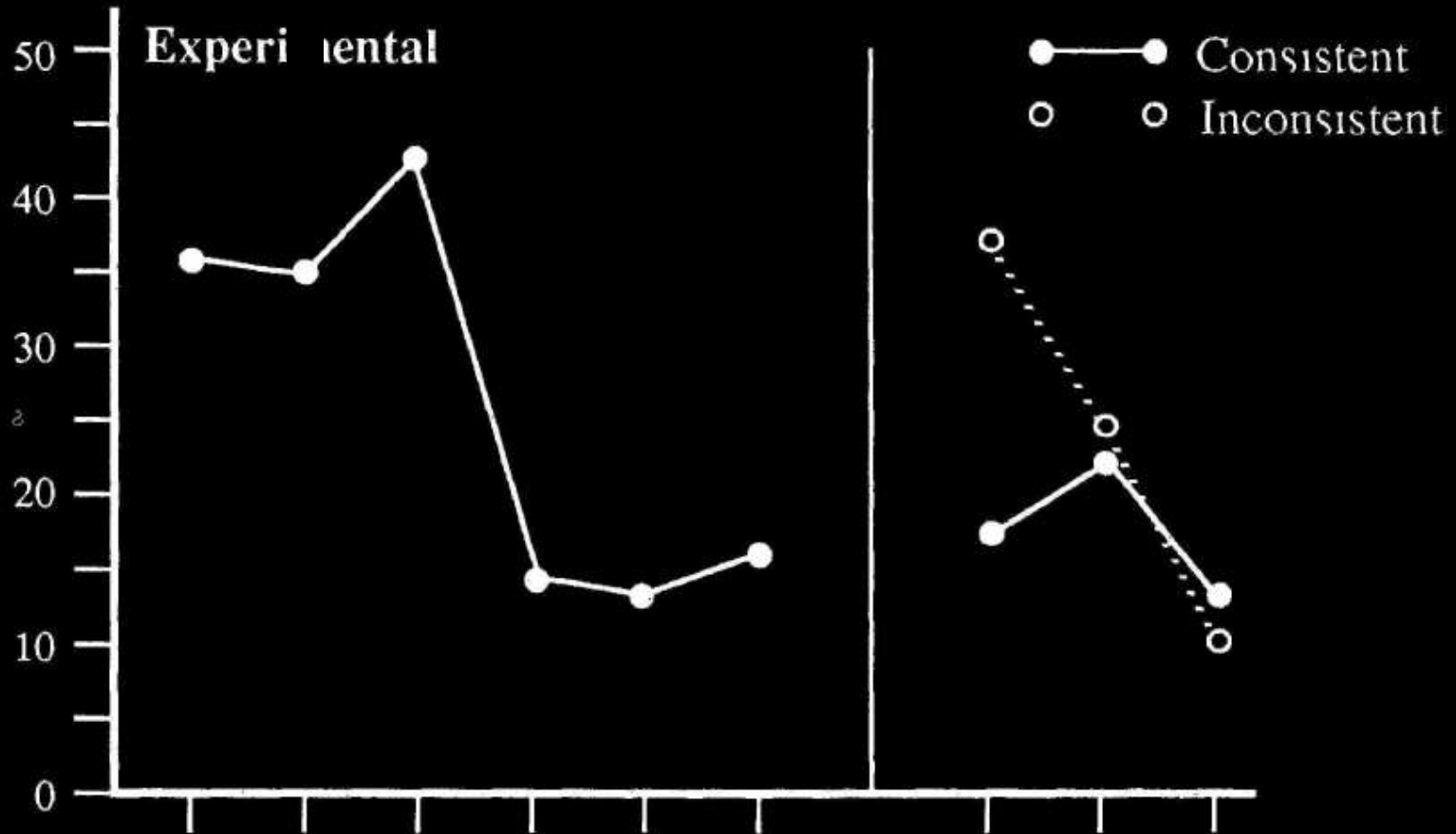
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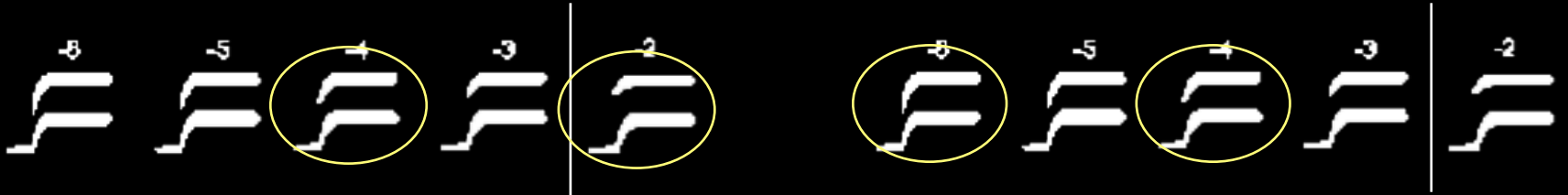


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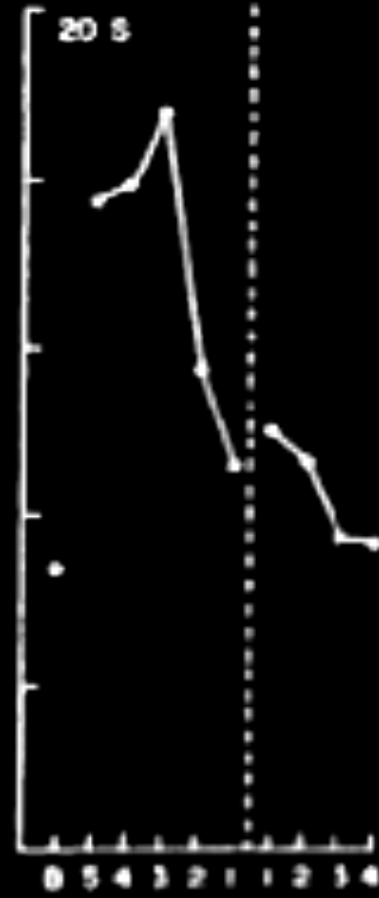
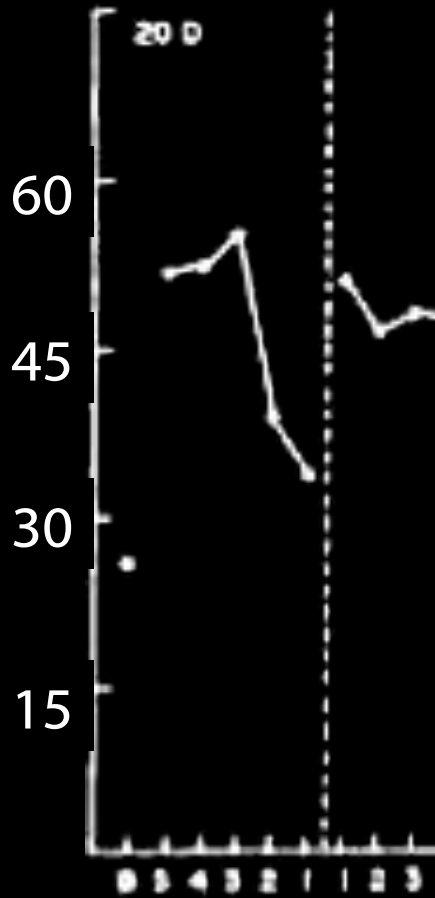


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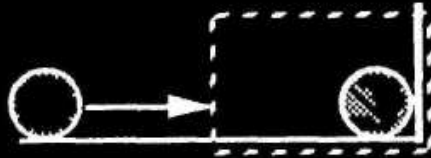




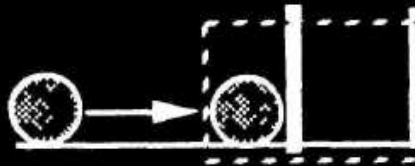
mean number of sucking responses per minute



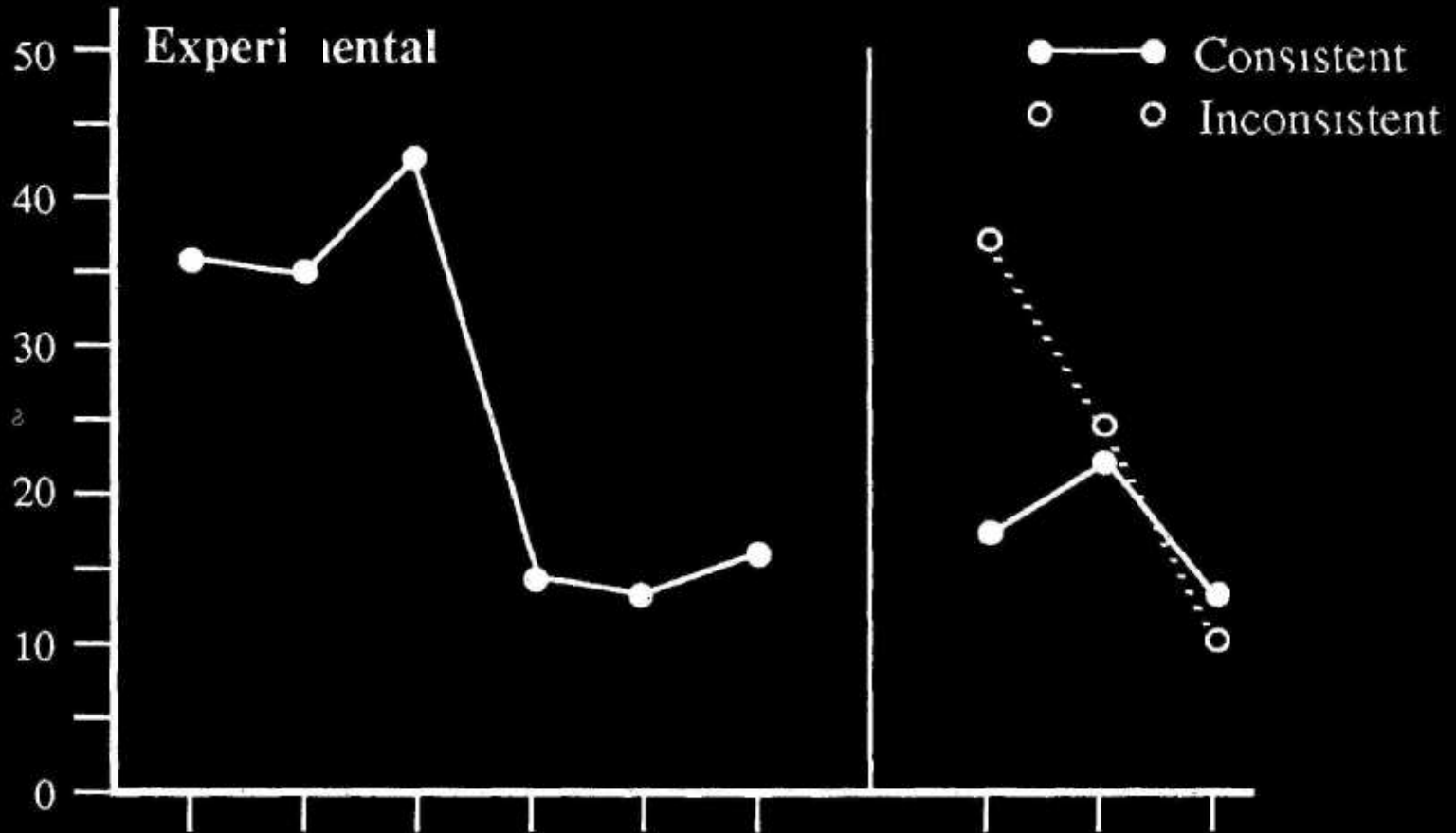
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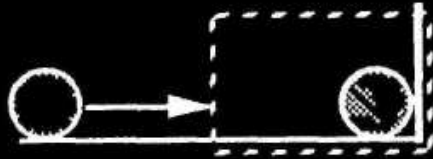
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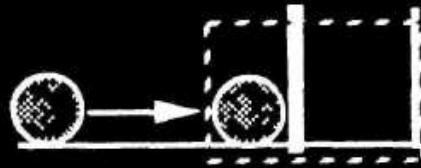
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habituation



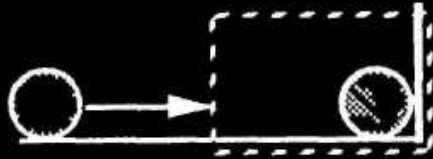
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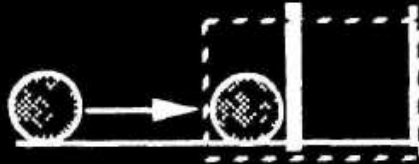
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habituation



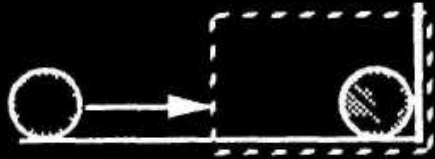
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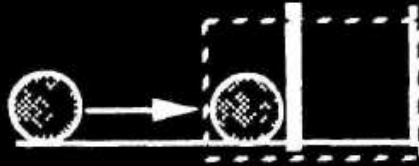
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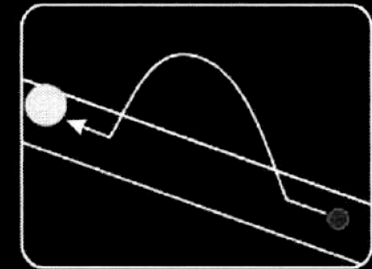
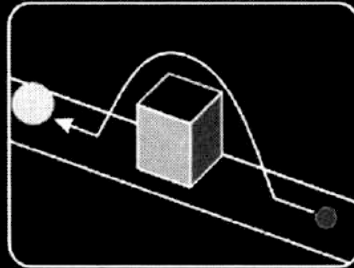
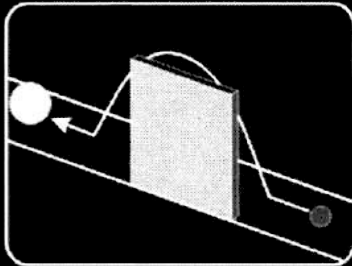
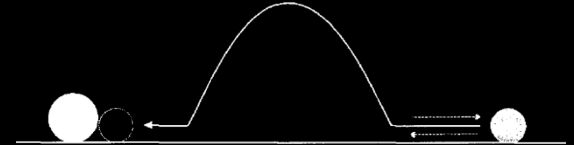
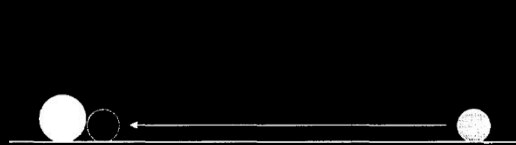
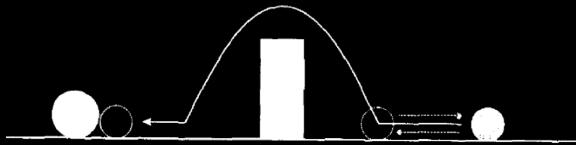
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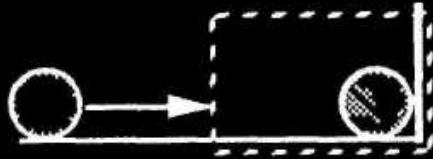
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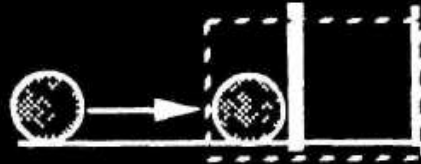
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