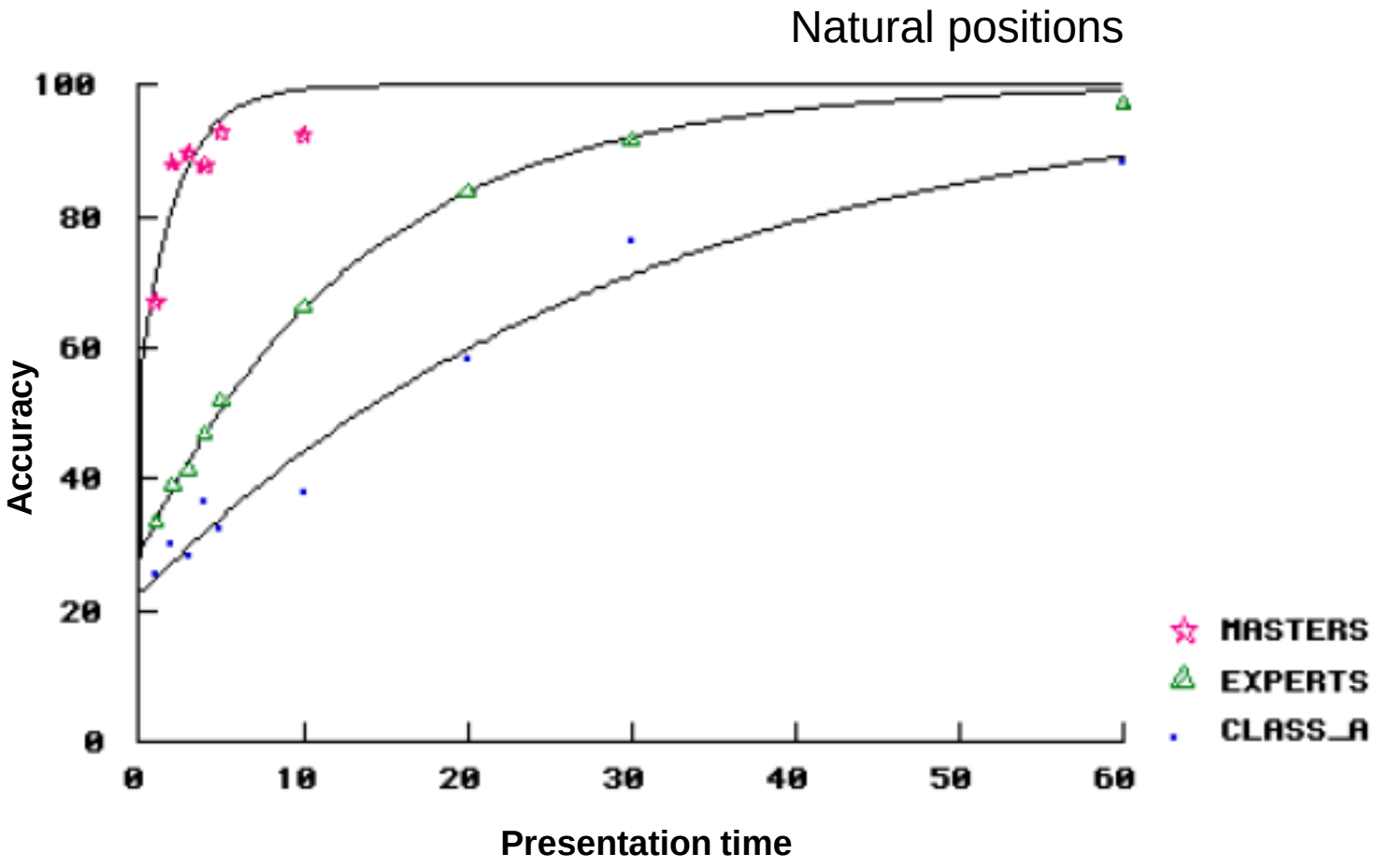
Expertise

Expertise: Nature vs Nurture

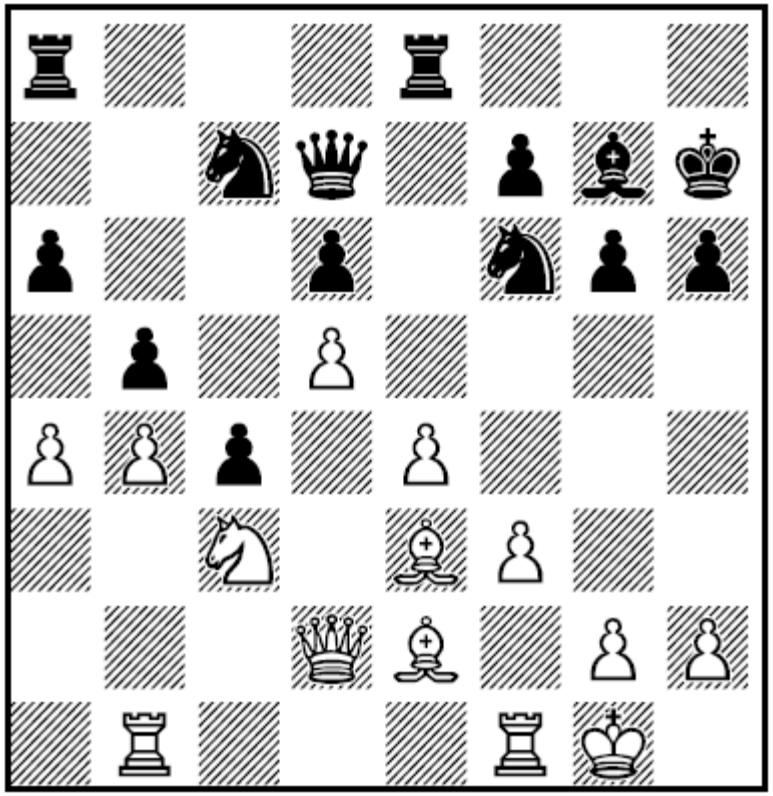
- Prevalent view: Nature has a strong role
  - Chess players: “naturally endowed”, “highly intelligent”
- [de Groot 1946] : chess expertise
  - Only the best moves are considered
  - Selection restrictions → pattern-based retrieval from memory
- How does expertise work, given limited working memory?
  - Acquired patterns → chunks

Chess board recall



[Gobet and Simon 2000]: Five seconds or sixty?

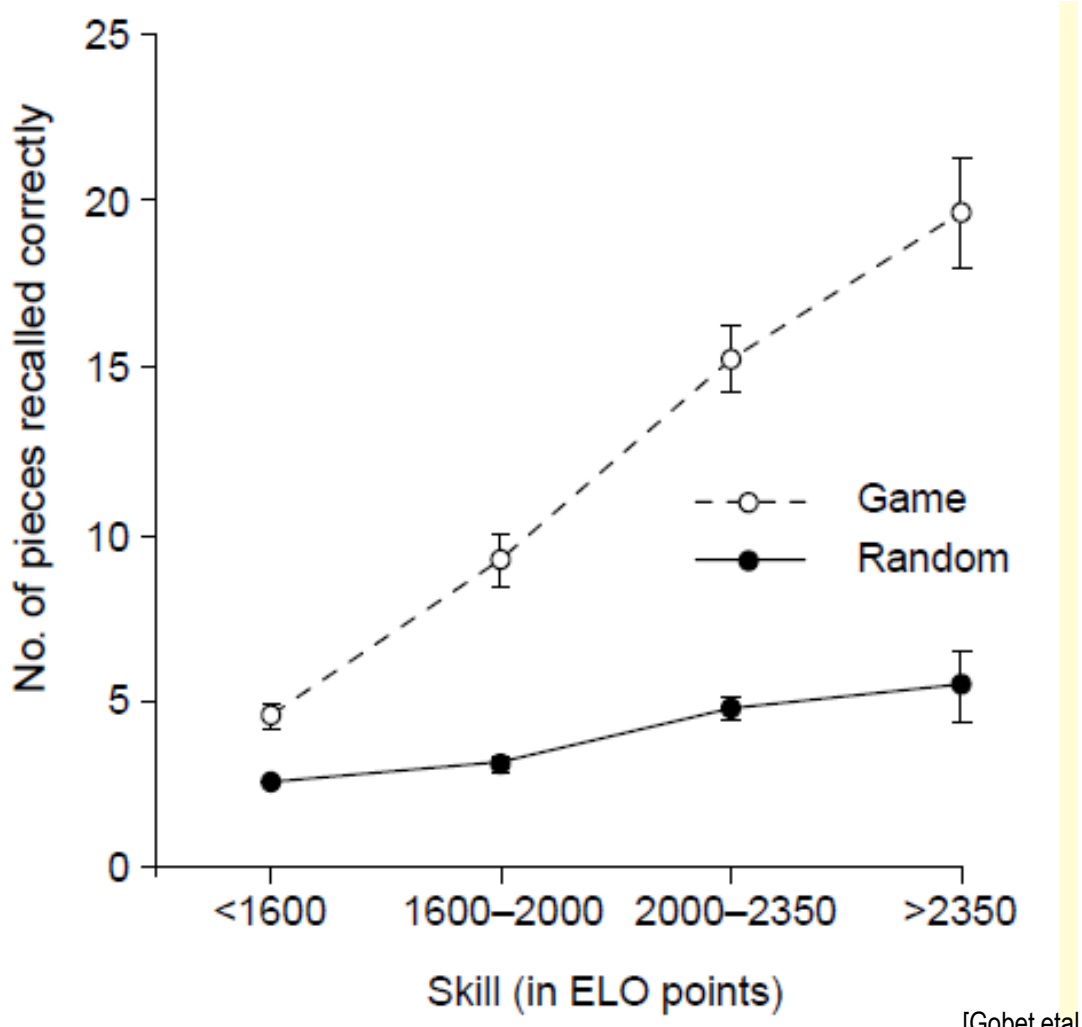
Chess board recall



Random position

[Gobet etal 2001] Chunking mechanisms

Chess board recall



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  - Only the best moves are considered
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- How does expertise work, given limited working memory?
  - Acquired patterns → chunks
- Experts do not seem to have unique genetic characteristics
  - Expert performance is very domain-restricted

Applies to all skilled activity

- Physics problem solving [Larkin etal 1980]
  - Beginners: start with problem definition and try to deduce solution
  - Experts: solution is part of comprehension of the problem
- In some domains, no advantage for experts
  - Statistical regression outperforms (or equals) experts
  - Better performance in deep theory domains – medicine, bridge
    - E.g. Nurses screening emergency calls
  - Auditors: no advantage with experience

Integration of domain knowledge

analogy

Simple / Familiar
Reaction Time;
Sentence-Picture
verification

[Necka/Orzechowski 05]

Integration of domain knowledge

Simpl
Reac
Sente
ve

Complex/Novel
Real-world
microworlds

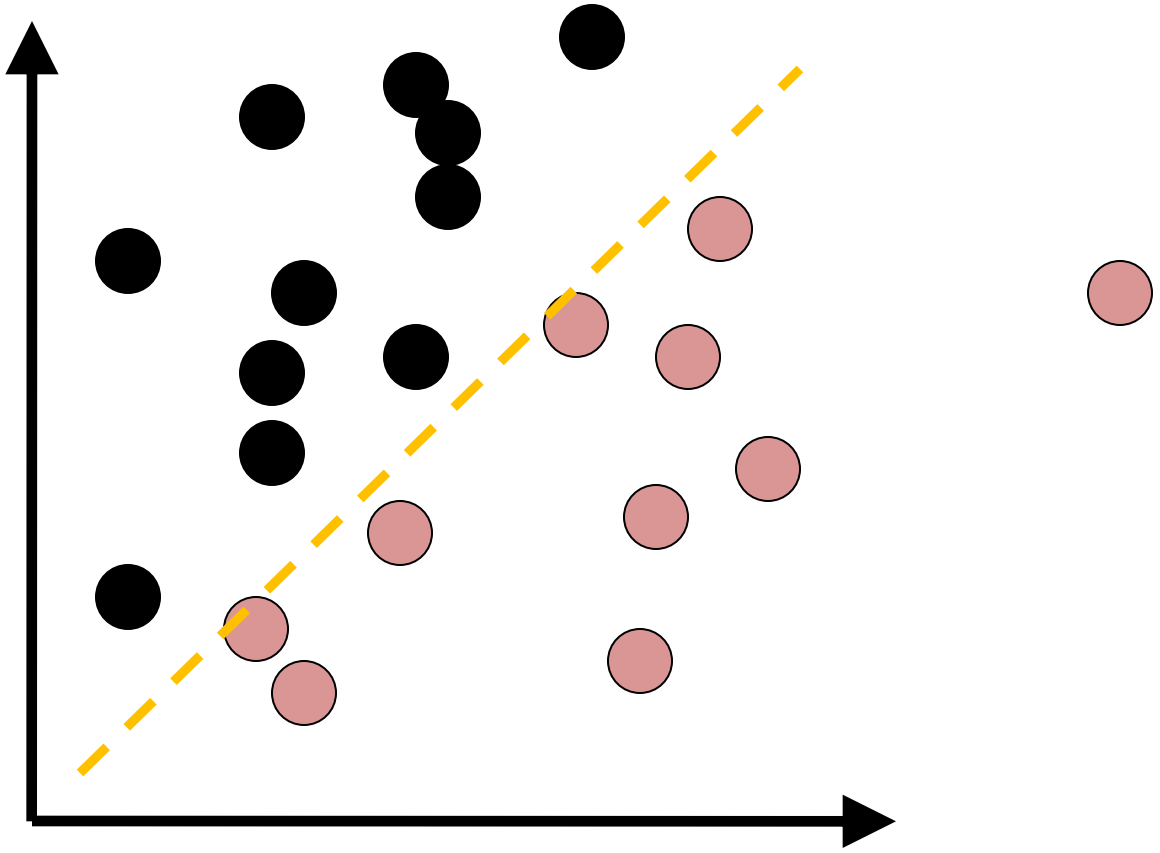
[Necka/Orzechowski 05]

Development of Expertise

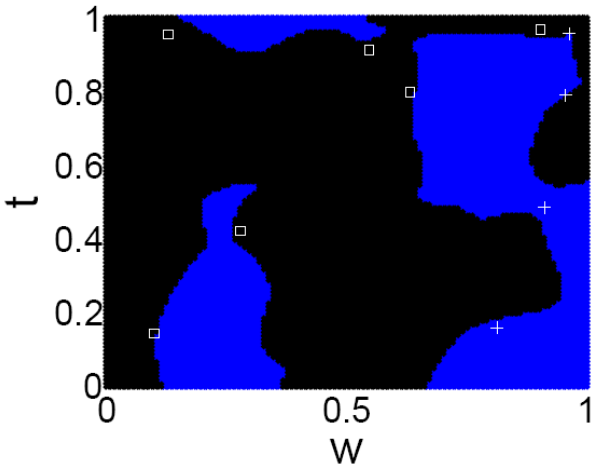
- Initial patterns may not be very reliable
  - Confidence associated with chunks
- Only stable chunks are candidates for symbolization

- Computational models:
  - Simulate sequence of errors in developmental process

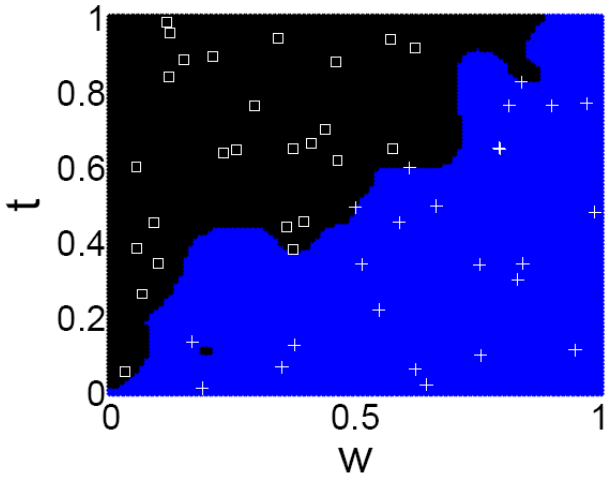
Baby-like learning: “containment”



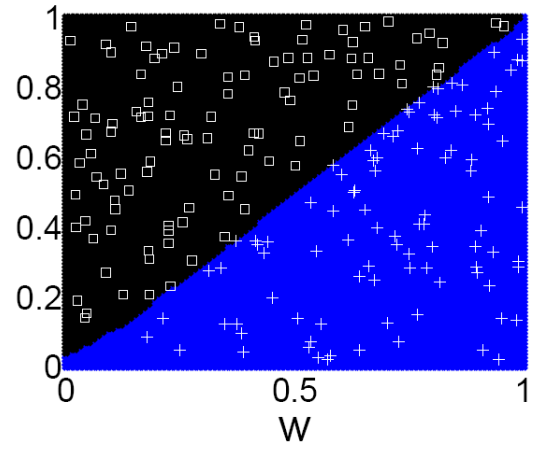
Baby-like learning: “containment”



10 instances



50 instances



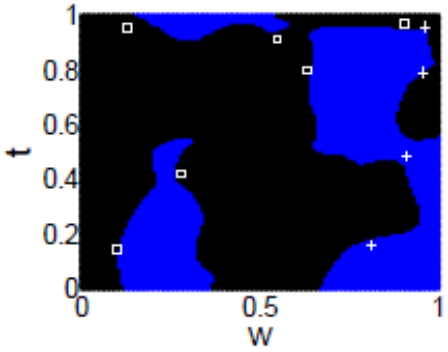
200 instances

[Dabbeeru Mukerjee DCC 2008]

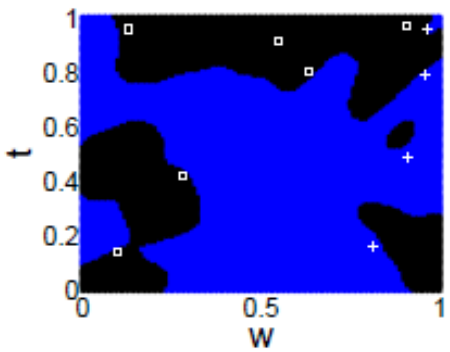
-
- ***“grounded” :*** defined outside the symbolic domain, in sensorimotor data. (hence not CIRCULAR)

Convergence in mental models

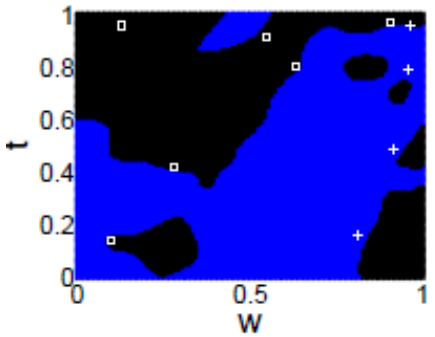
Early experiences may vary (N=10)



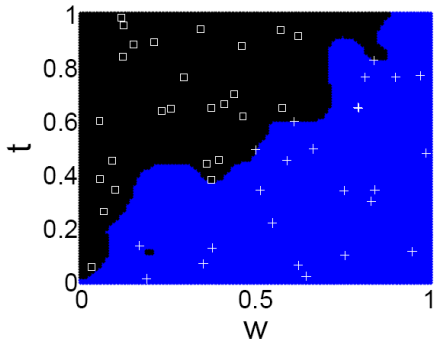
baby 1

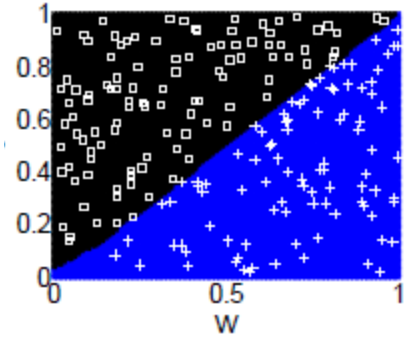


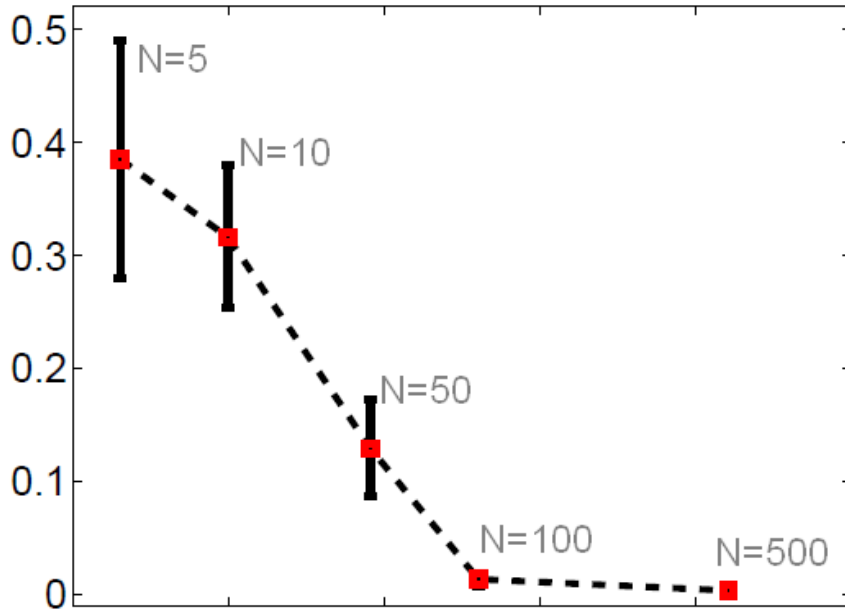
baby



But converge when task is familiar :







Development

Object → Relation → Event Acquisition

9-30 min after birth	- Face vs scrambled face in moving images [Goren et al 75, Kellman/Arterberry 98]
2.5 months	- dynamic ACTION TRACKING [Aguiar/Baillargeon98, Spelke 95] - Objects to remain occluded behind occluders [Aguiar/Ballargeon 99] - Containment: needs open top [Hespos/Baillargeon 02]
3-5 months	- OBJECT VISUAL CATEGORIES : *CAT* class excludes dogs, but *DOG* include cats → asymmetry [Mareschal/French/Quinn:00]
5 months	- Earliest evidence of SHAPE discrimination [McMurray-Aslin:2004] - tight vs loose CONTAINMENT [Hespos/Spelke:2004]
6 months	- dynamic **tracking** through OCCLUSIONS, motion prediction [Gredebaeck/vonHofsten:2004] - learns **background** before figure [Coldren&Haaf 1999] - EVENT categorization for occlusion events [Baillargeon/Wang:02]
12 months	- EVENT STRUCTURE for actions (e.g. *DRINK*) [Mareschal/French/Quinn:00]

Spatial Relations Development

2.5 months	CONTAINMENT needs open top [Hespos Baillargeon 02]
3 months	dot ABOVE/ BELOW bar[Q] not on novel shapes
5 months	tight vs loose CONTAINMENT
6 months	- CONTAINMENT shape-indep[Q} - CONTAINMENT from diff views [C] - BETWEEN shape-dependent [Q]
9 months	shape-indep BETWEEN[Q]

Cognitive Architecture: Levels of Abstractions