Comparative studies of categorization: Pigeons, humans and squirrels

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PSYCHOLOGY
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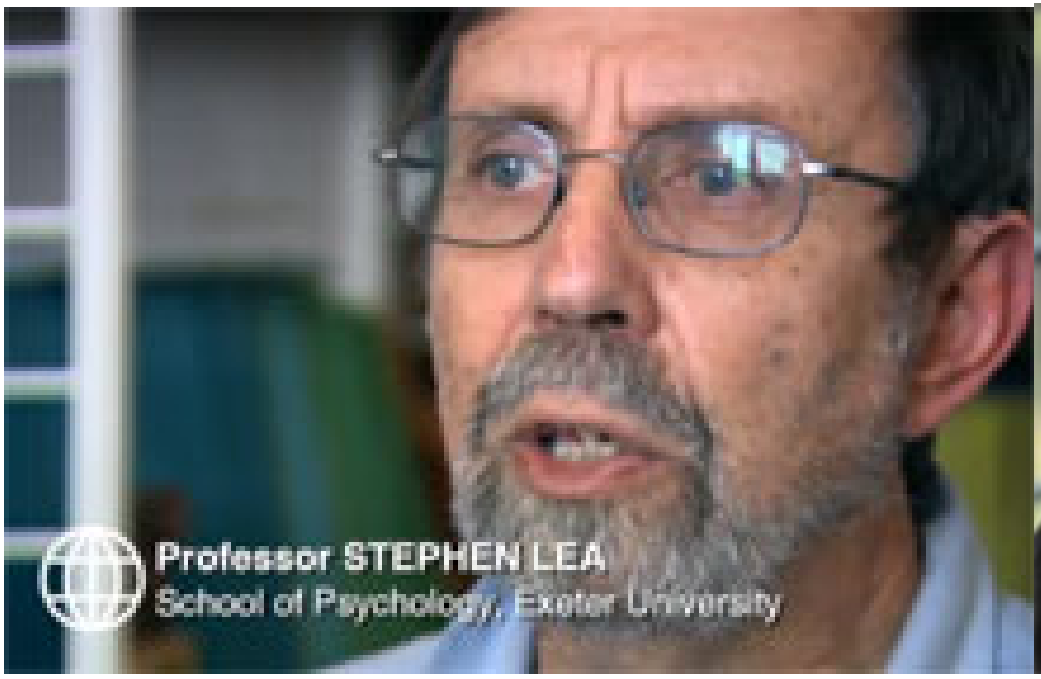
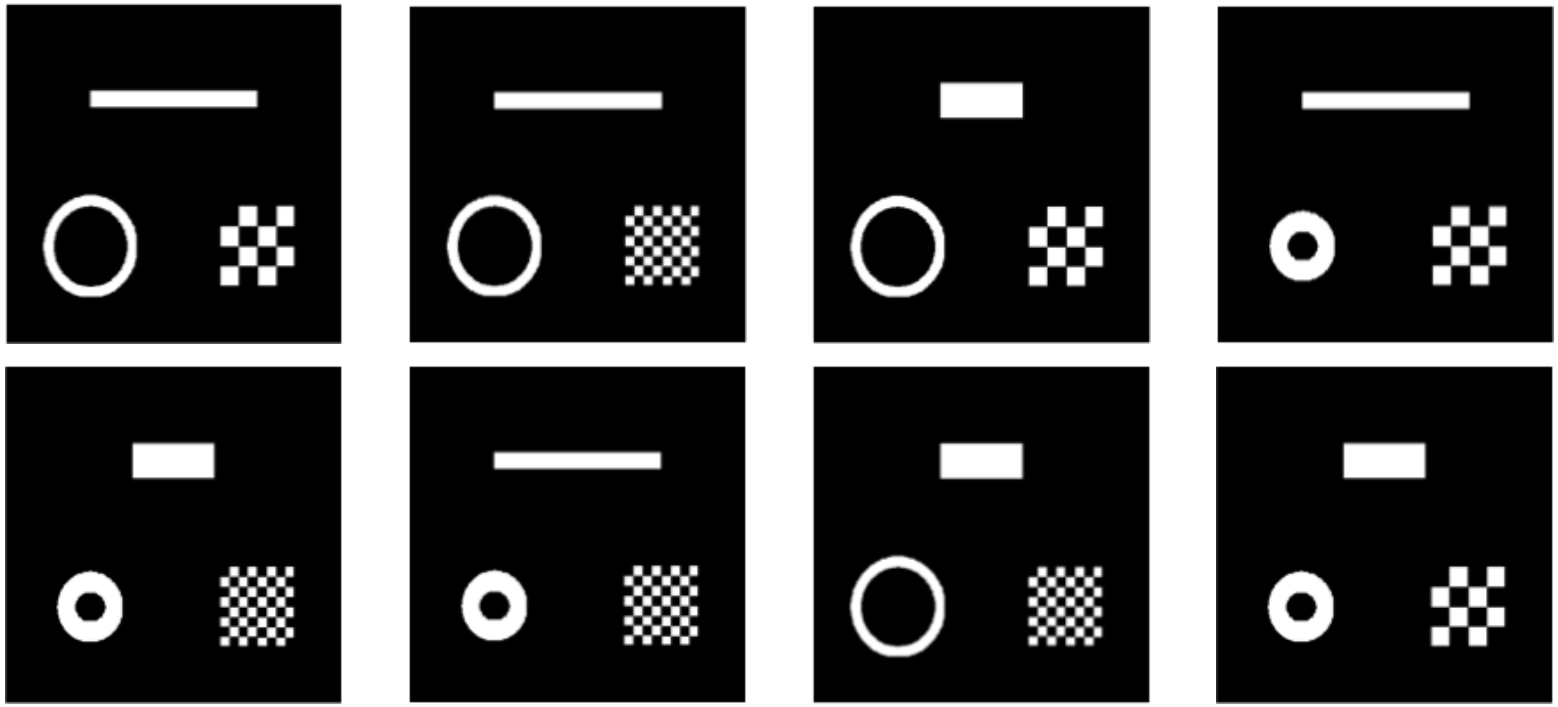
Collaborators



Rules versus overall similarity

- **Overall similarity classification**: Consideration of all experimenter-defined stimulus dimensions in a relatively unweight/undifferentiated manner.
- **Dimensional classification**: One stimulus dimension has essentially complete control over responding.

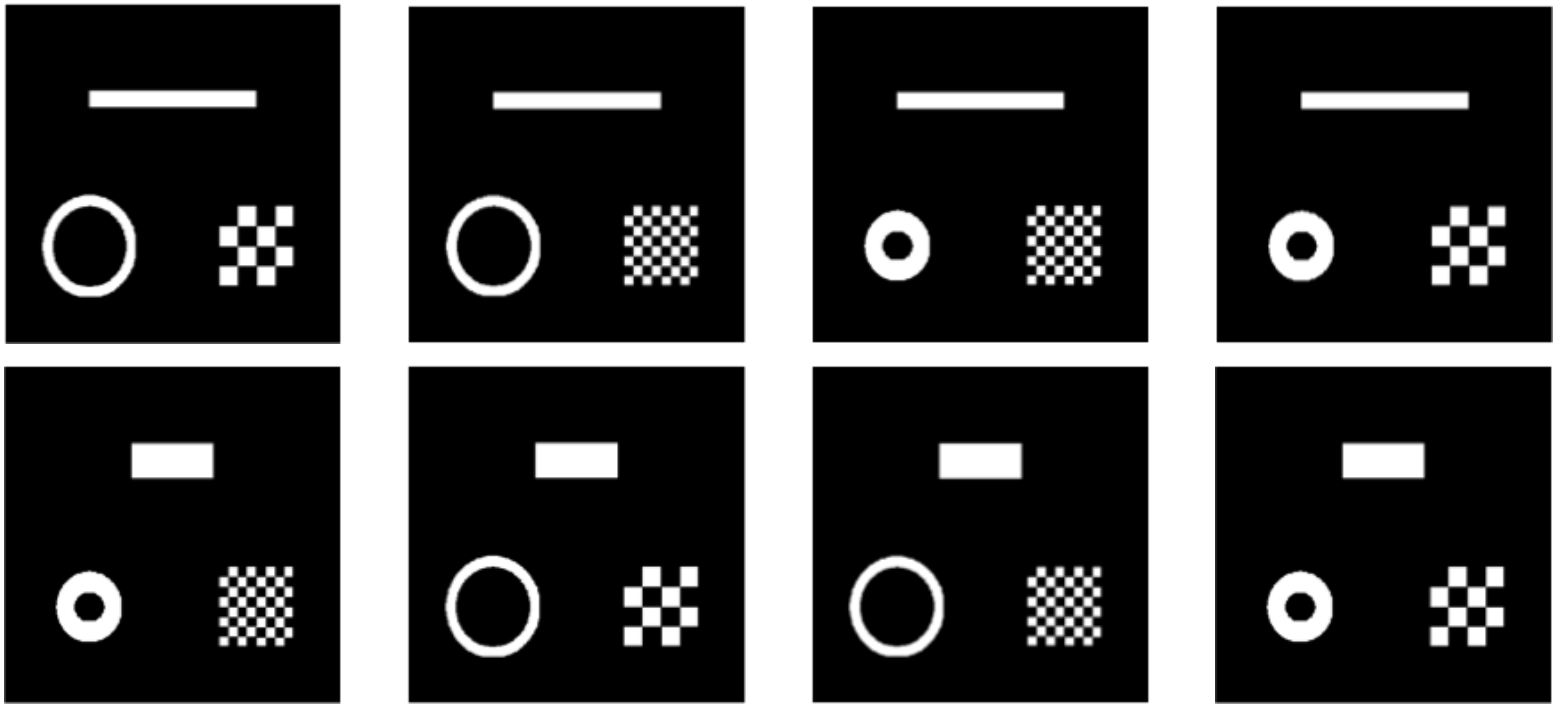
Concrete example - OS classification



Prototypes

One-aways

Concrete example - Dimensional classification



Prototypes

One-aways

Overall similarity as the "fallback" mode

- "Family resemblance categorization is the default mode of approach to tasks when full executive functioning is underdeveloped, inhibited, or lacking for any reason" (Couchman et al., 2010, p. 180).
- "In many situations, it is easier for people to base similarity and categorization judgments on more, rather than fewer, properties" (Goldstone & Barsalou, 1998).
- **OS classification more prevalent in pigeons/squirrels than in humans?**

Reasons to be doubtful

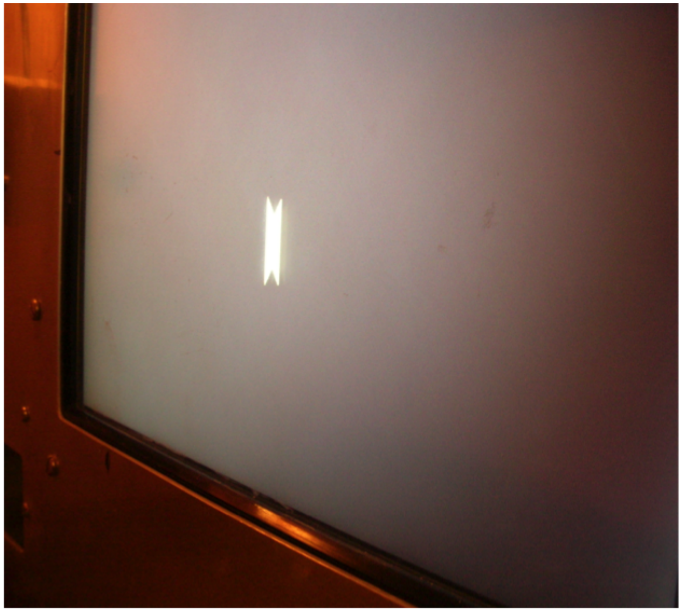
- Counter-intuitive "less is more" hypothesis.
- Difficulty of obtaining reliable multi-feature control over responding in pigeons (e.g. Lea, Wills & Ryan, 2006).
- In humans, overall similarity can (at least under some conditions) be more effortful than single-dimension classification (e.g. Milton, Longmore & Wills, 2008; Milton, Wills & Hodgson, 2009; Wills et al., 2013).

Contrasting hypotheses

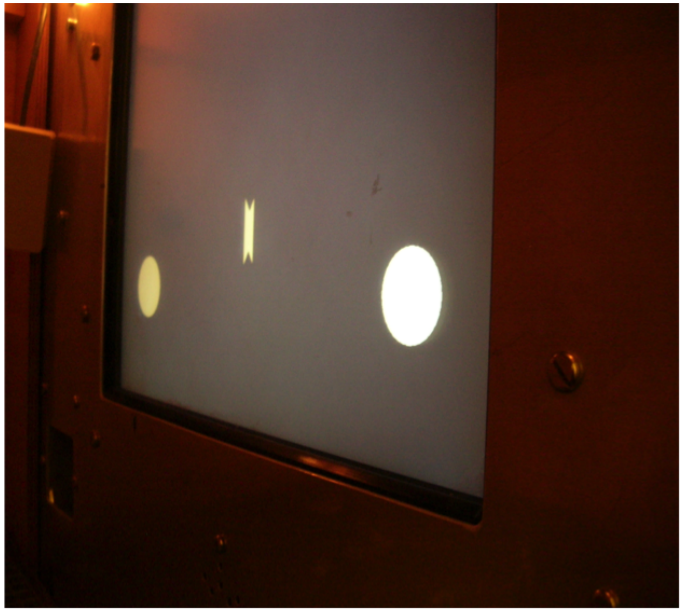
1. OS prevalence higher in pigeons/squirrels than in humans
2. OS prevalence affected by stimulus variables in a similar way across species.

Pigeon apparatus

General procedure



Peck for 10 s



Side keys appear

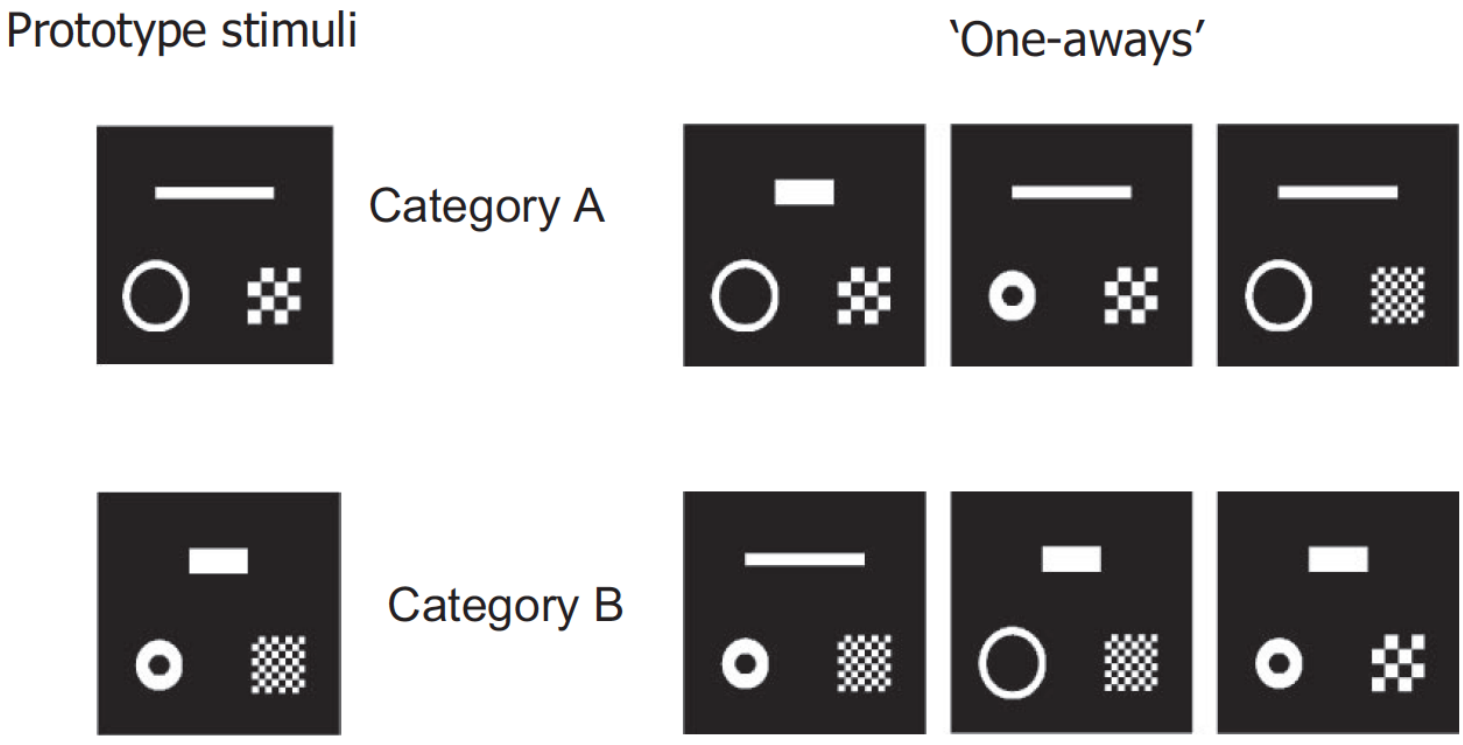
Phase 1

Category A

Lozenge Doughnut Bar Checks

Category B

Phases 2-3



Human analogue task

- Procedurally similar task, but...
- Experiment complete within one session.
- Reinforcement was a smiley face and a points increment.

Results

	Consistent with control by					
	Bar	Checks	Lozenge	Doughnut	Overall similarity	Apparent strat
Pigeons						
As	39%	61%		58%	58%	Checks
At	39%	72%		50%	61%	Checks
Ba	54%	51%		46%	51%	Bar (position bias)
Io	67%	67%		58%	72%	Overall similarity
Le		53%	53%	72%	64%	Doughnut
Ly	49%	49%		51%	64%	Overall similarity
Pn	49%	51%		49%	63%	Overall similarity
Sf	63%	54%		54%	65%	Overall similarity
Students						
1	67%	67%		67%	100%	Overall similarity
2	50%	83%		50%	83%	Overall similarity/checl
3	67%	67%		67%	100%	Overall similarity
4	50%	67%		67%	83%	Overall similarity
5	75%	58%	58%		92%	Overall similarity
6		67%	33%	67%	67%	Overall similarity/checl
7	58%	75%		58%	92%	Overall similarity
8	33%		33%	100%	67%	Doughnut
9		42%	42%	92%	75%	Doughnut
10	33%	33%		100%	67%	Doughnut
11	67%	67%		67%	100%	Overall similarity
12	67%	67%		67%	100%	Overall similarity

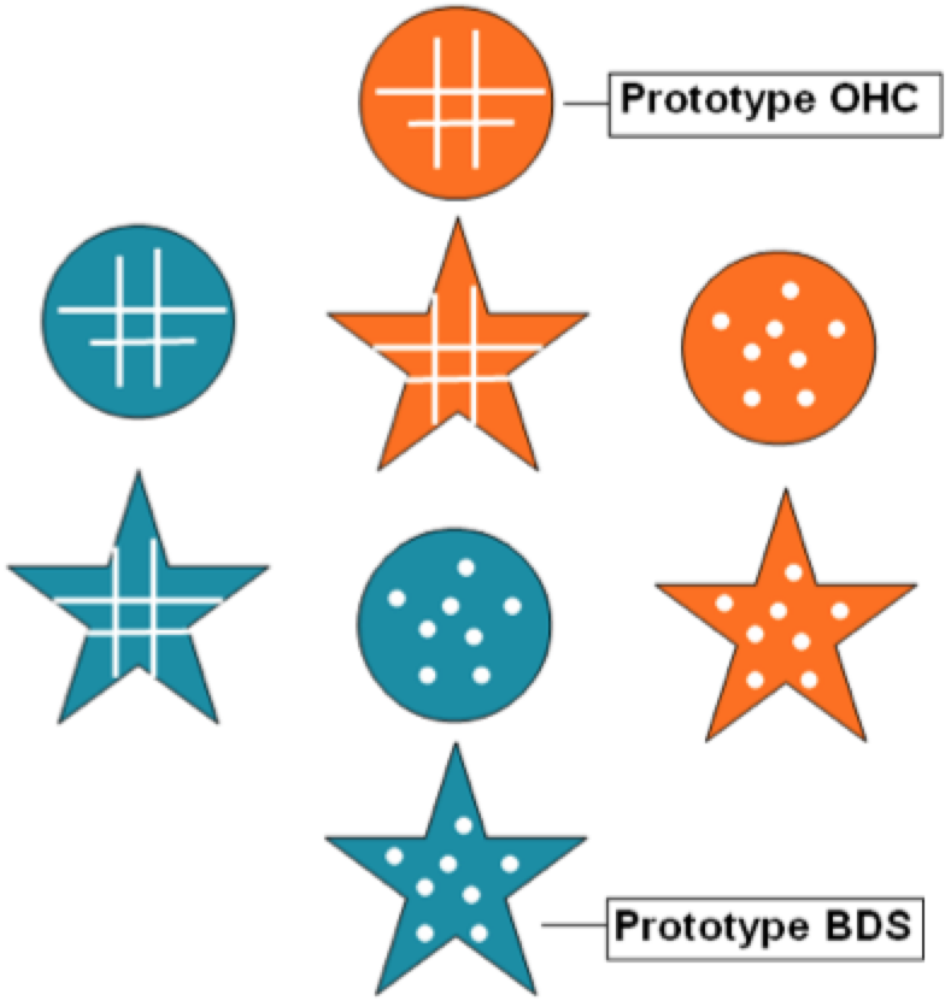
Results - summary

- If anything OS classification more prevalent in humans.
- Difference in prevalence rates not significant.

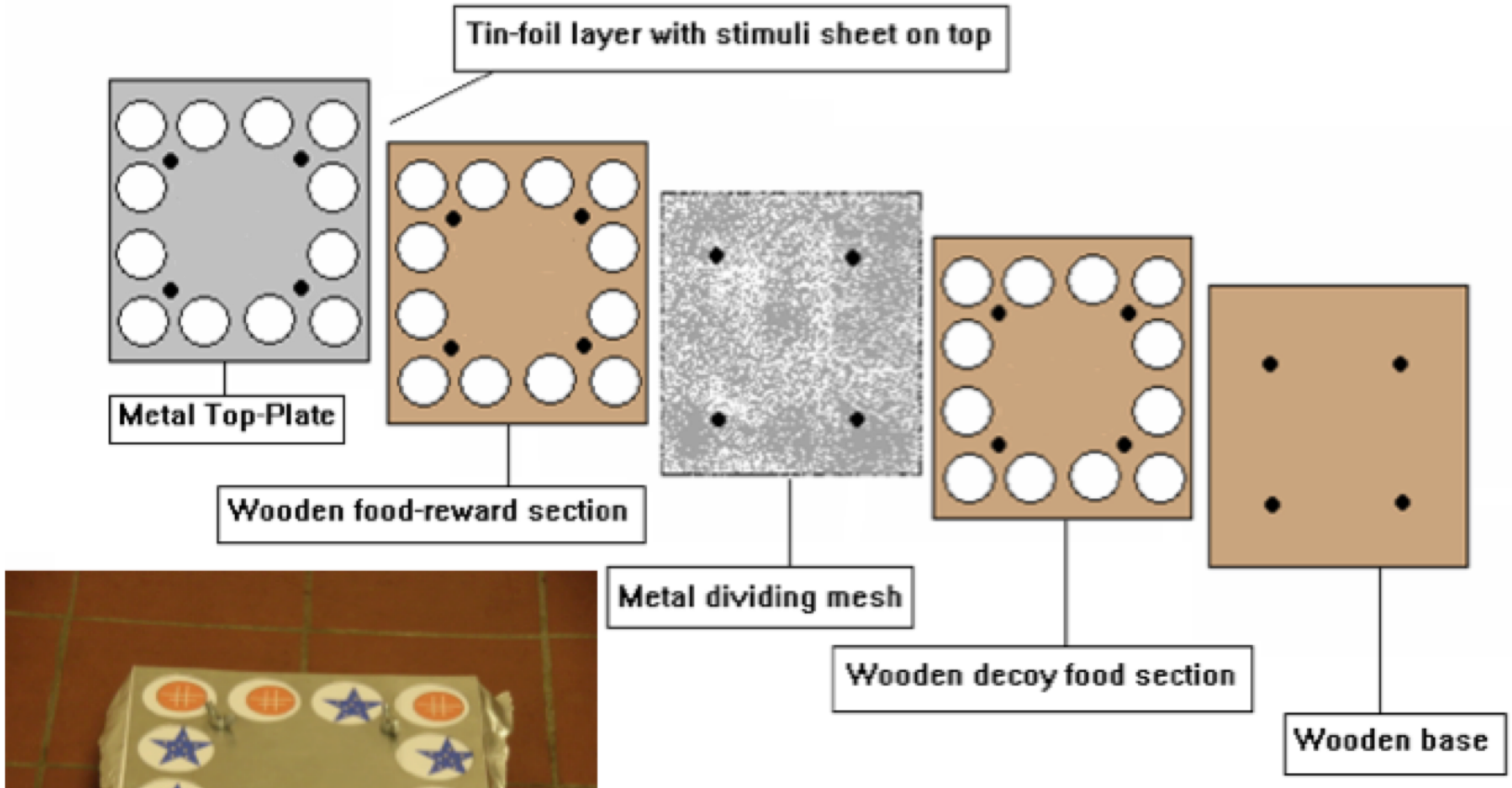
Experiment series 2

- Human work indicates that spatial integration would reduce OS prevalence (Milton & Wills, 2004). Will we see a similar stimulus effect across species?
- Develop a procedure that will procedure rapid learning in squirrels and pigeons, and for which we can have a reasonable human analogue task.

Stimulus set



Squirrel procedure

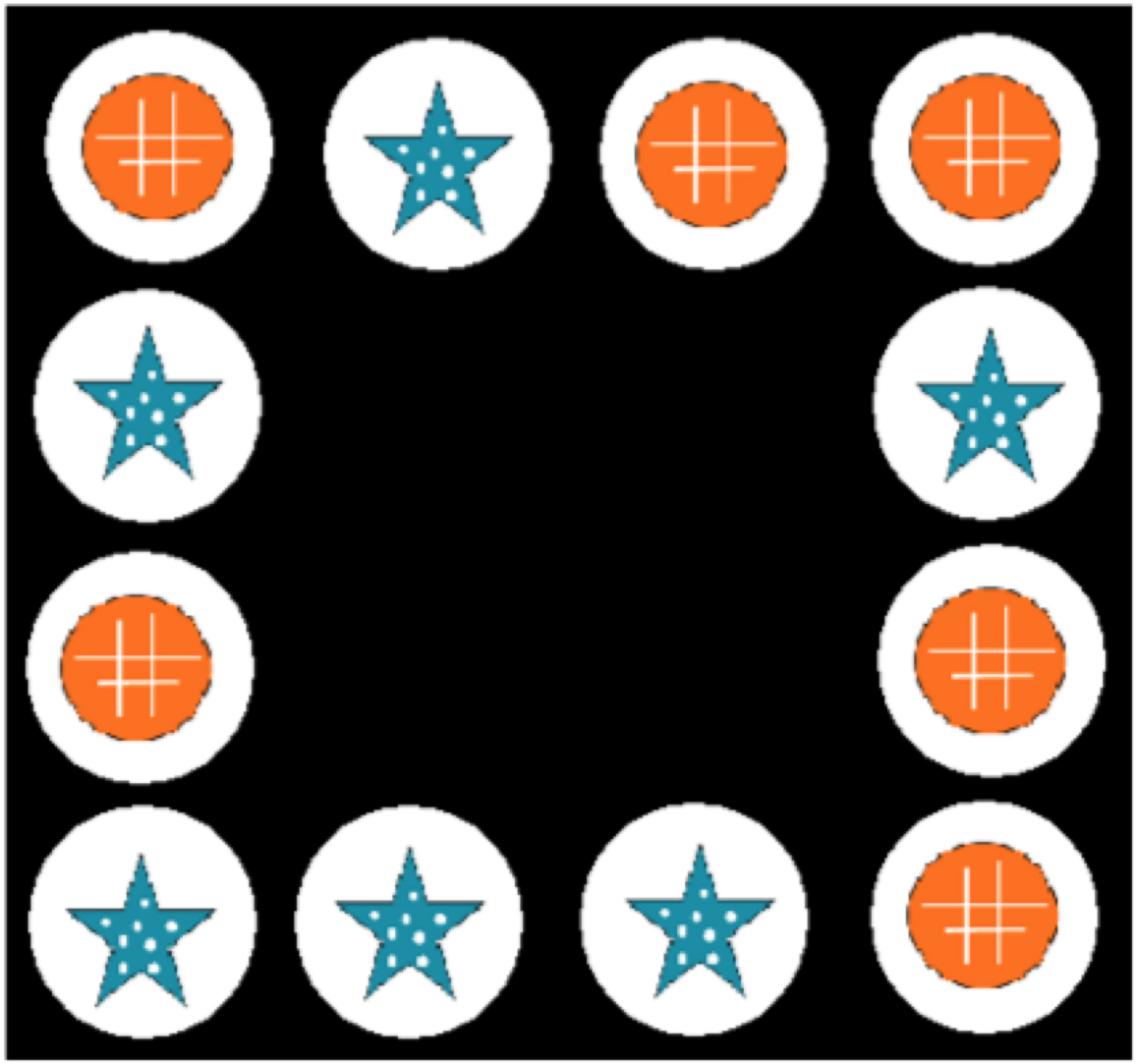


Squirrel-eye view of poke-box

Itchy the Squirrel Genius

PLAY VIDEO!

Pigeon, human procedure



Results

	Consistent with control by				
	Color	Shape	Pattern	Overall similarity	Apparent strategy
Squirrels					
Mo	53%	75%	36%	64%	Shape
It	83%	39%	44%	67%	Color
De	75%	36%	31%	42%	Color
Sy	72%	44%	22%	39%	Color
Pigeons					
Zb	81%	53%	53%	86%	Overall similarity
Rv	75%	47%	36%	58%	Color
Ot	75%	58%	31%	64%	Color
Rr	100%	33%	33%	67%	Color
Ra	92%	47%	42%	75%	Color
Rp	97%	36%	31%	64%	Color
Students					
1	67%	50%	67%	83%	Overall similarity
3, 5, 6	67%	33%	67%	67%	
4	50%	67%	33%	50%	Shape
7	75%	42%	25%	42%	Color
9	67%	67%	67%	100%	Overall similarity
10, 24	83%	50%	50%	83%	
11, 21	67%	67%	33%	67%	
12	50%	50%	67%	67%	
13	100%	33%	33%	67%	Color
14	50%	50%	83%	83%	
15	50%	83%	50%	83%	
16	33%	67%	33%	33%	Shape
18, 19	83%	50%	17%	50%	Color
20	25%	75%	58%	58%	Shape
22, 23	50%	83%	50%	83%	

Results - summary

- Change of procedure reduces OS prevalence for pigeons, humans.
- If anything, humans more OS than pigeons, squirrels.

Section 1 conclusion

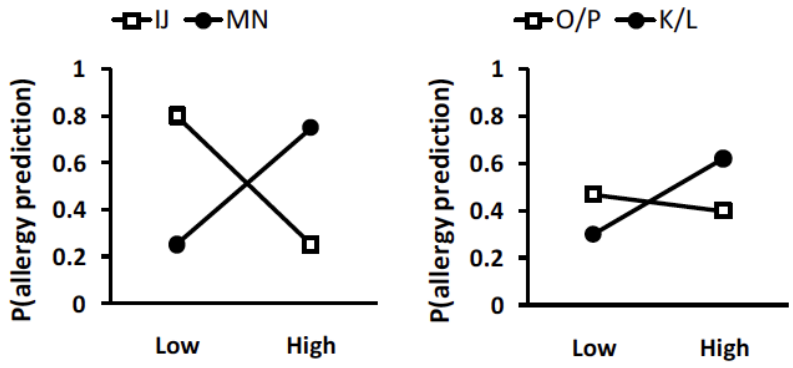
- No evidence from these comparative studies to support overall similarity as a "fallback" mode of classification where cognitive resources are limited.
- Let's try a different operationalization of "rules versus similarity".

Shanks & Darby (1998)

A.

Training			Test		
A+	B+	AB-	A?	B?	AB?
C-	D-	CD+	C?	D?	CD?
E+	F+	EF-	E?	F?	EF?
G-	H-	GH+	G?	H?	GH?
I+	J+		I?	J?	**IJ?**
		KL-	**K?**	**L?**	KL?
M-	N-		M?	N?	**MN?**
		OP+	**O?**	**P?**	OP?

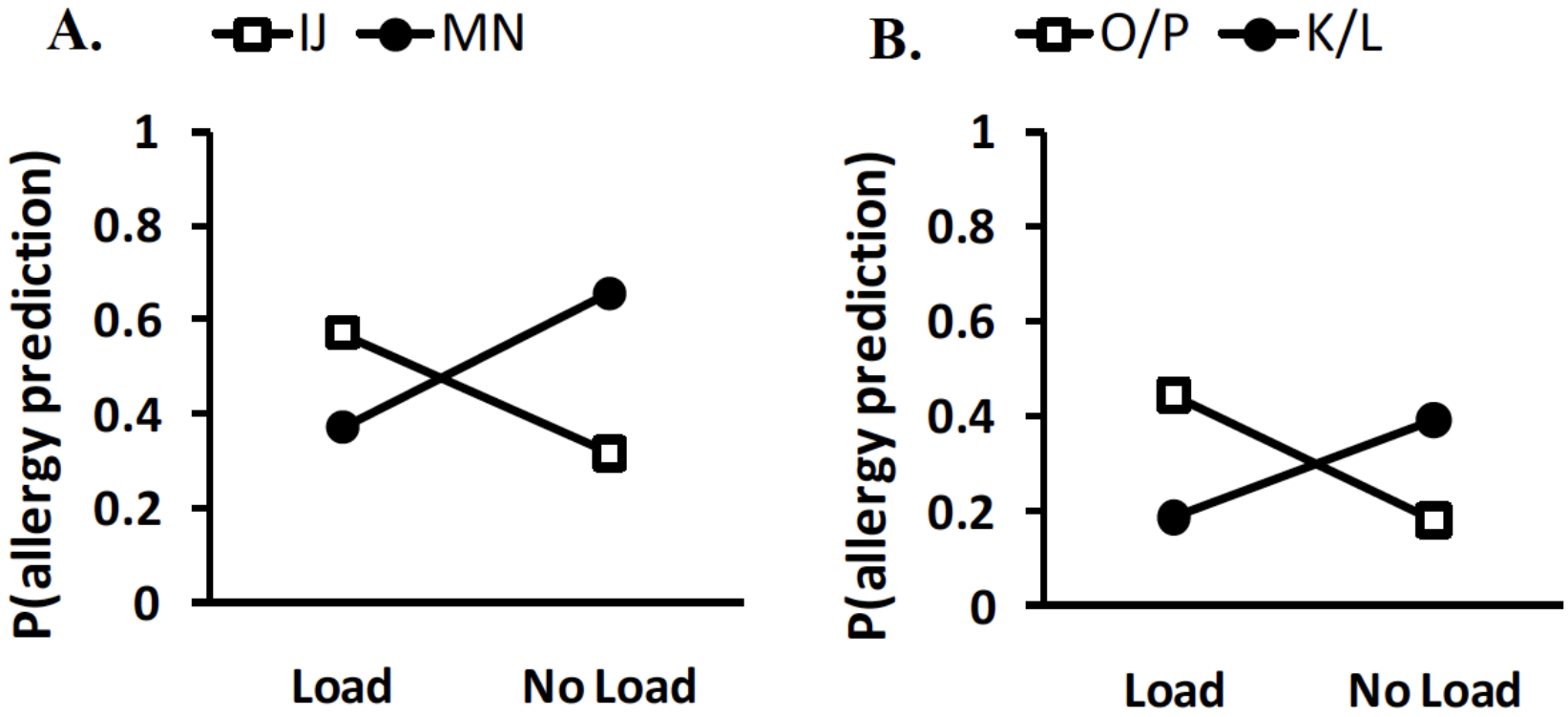
B.



Similarity-based inference - IJ makes Mr.X sick.

Rule-based inference - IJ is fine.

Wills et al. (2011, JEP:ABP)

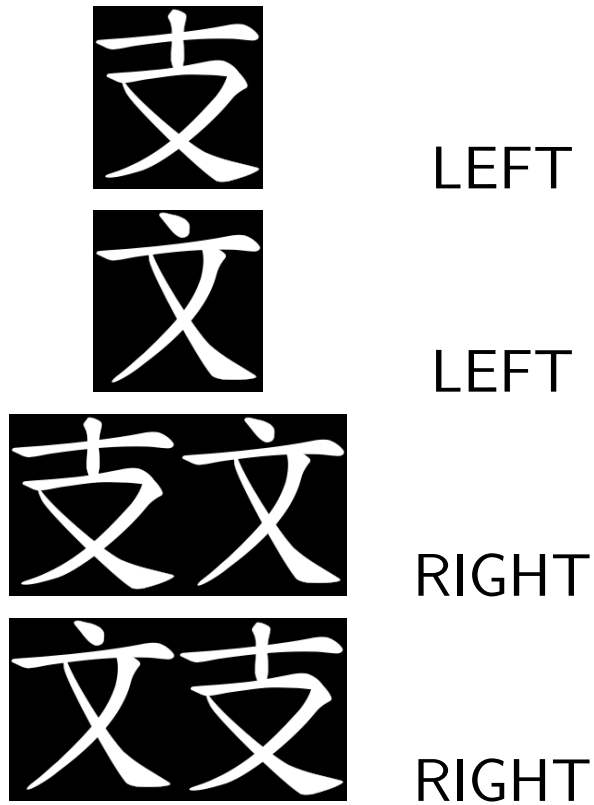


Everyone trained to 90% accuracy.

Concurrent load: Similarity-based inference - IJ makes Mr.X sick.

Full attention: Rule-based inference - IJ is fine.

Pigeon Shanks-Darby



Pigeon Shanks-Darby

T1 (One complete pattern)

LEFT	A,B					
RIGHT	AB,BA					

T2 (Another complete pattern)

LEFT		CD,DC				
RIGHT		C,D				

T3 (2 complete patterns)

LEFT	A,B	CD,DC				
RIGHT	AB,BA	C,D				

T4 (2 complete patterns, 2 incomplete patterns)

LEFT	A,B	CD,DC		GH,HG		K,L
RIGHT	AB,BA	C,D	E,F		IJ,JI	

T5 (4 complete patterns)

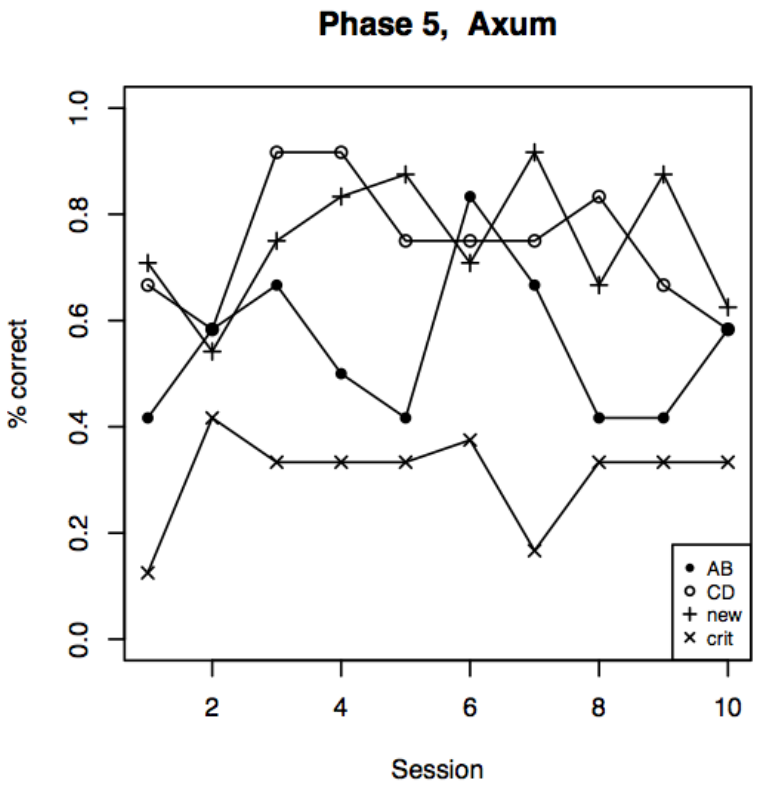
LEFT	A,B	CD,DC	EF,FE	GH,HG	I,J	K,L
RIGHT	AB,BA	C,D	E,F	G,H	IJ,JI	KL,LK

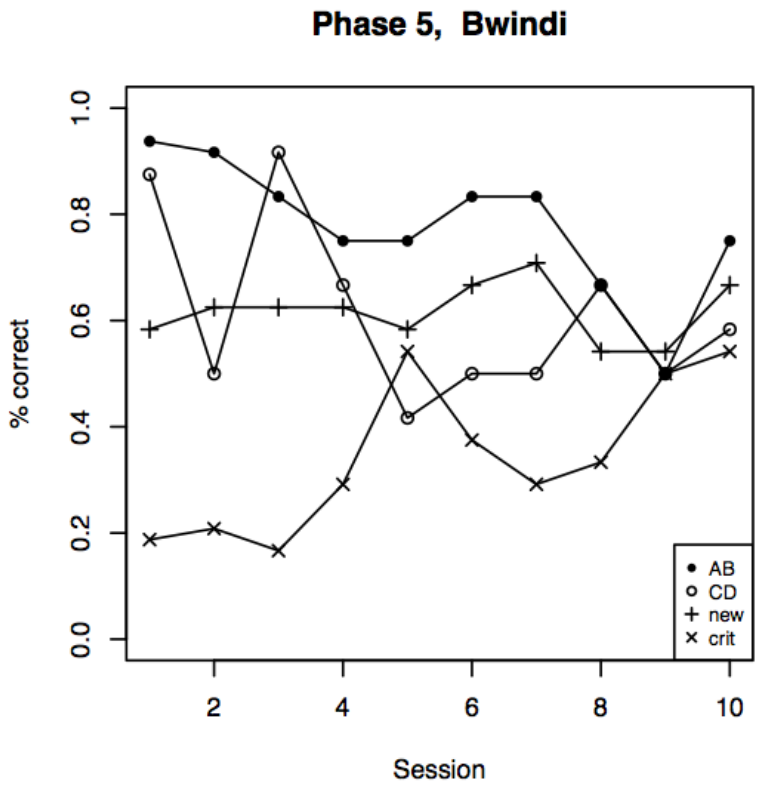
Pigeon Shanks-Darby

Results

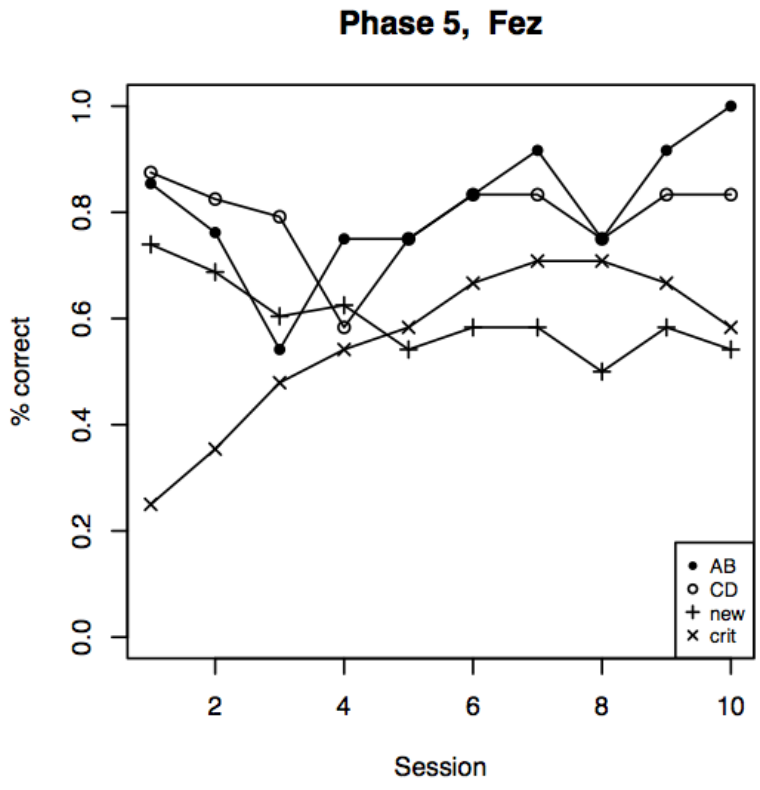
- Phase 1 (AB) - 4 to 6 sessions to crtierion.
- Phase 2 (CD) - Below chance initially. 12-35 sessions to criterion.
- Phase 3 (AB,CD) - One bird died. Of remaining six, five hit criterion (10-60 sessions). The other one made it to .70 after 60 sessions. All moved to Phase 4.
- Phase 4 (AB,CD,incompletes) - Two birds to criterion. Others at .66 - .75. 6-70 sessions.

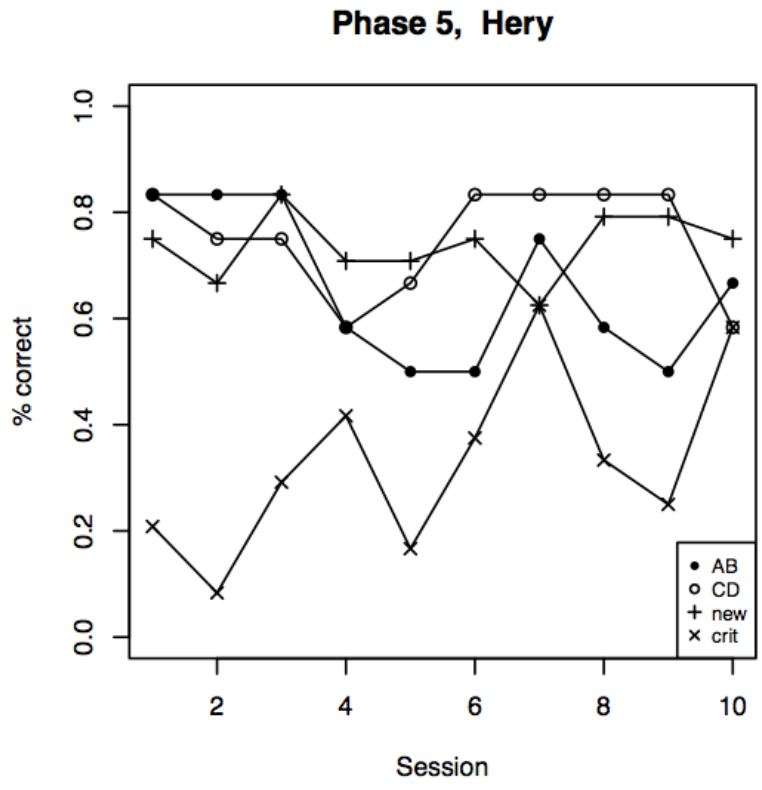
Results


Phase 5, Axum
% correct
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
Session
AB
CD
new
crit

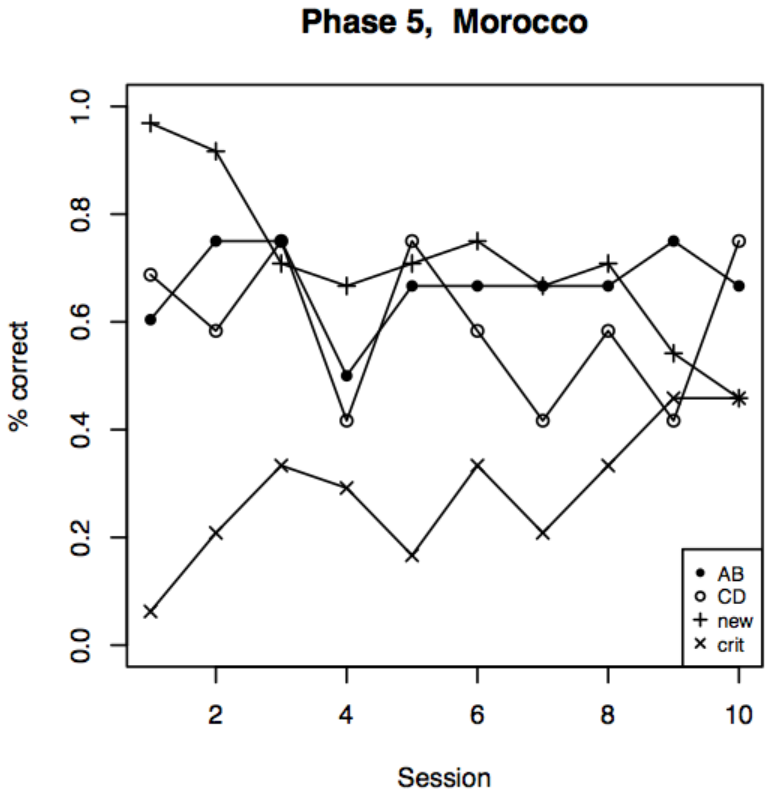

Phase 5, Bwindi
% correct
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
Session
AB
CD
new
crit

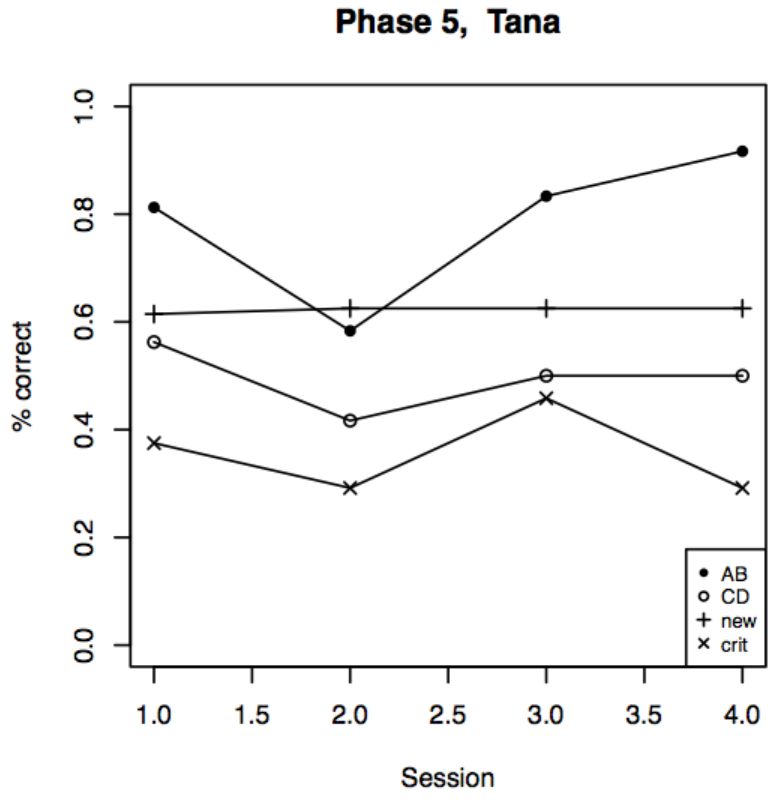
Results


Phase 5, Fez
% correct
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
Session
AB
CD
new
crit


Phase 5, Hery
% correct
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
Session
AB
CD
new
crit

Results


Phase 5, Morocco
% correct
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
Session
AB
CD
new
crit


Phase 5, Tana
% correct
0.0
0.2
0.4
0.6
0.8
1.0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Session
AB
CD
new
crit