The Modal Research Design for SFT Application in Face Perception: Conjunctive/Disjunctive-rule Stimulus Structures (AND/OR) & a Novel Signature of Holistic Face Perception: "Snake Wiggle".

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The holistic hypothesis: Objects are perceived as whole entities and not as a sum of independent features

Analytic, or feature-based hypothesis: Objects are perceived as a simple sum of independent features

Systems Factorial Technology

SFT

Systems factorial technology (SFT)

- Donders (1868), Subtraction method, pure insertion
- Sternberg – Additive factor method (1969)
- Development of mental networks (Schweickert, 1978, 1982), Townsend & Schweickert's *trichotomy* method (1985, '89), Schweickert, Georgini and Dzhafarov 2000.
- Townsend et al stochastic modeling theory (1984, '83, 95).
- Validation and extensions of SFT (Fific, 2006; Townsend & Fific, 2004; Fific, Nosofsky, Townsend, 2008; Fific, Townsend & Eidels, 2008)

SFT designs in a nutshell

- The number independent variables = the number of processes under examination, *n*.
- Each independent variable should vary between binary values of saliency. The saliency is operationally defined as a manipulation that selectively influences a single process of interest, such that the process is speeded up (H=high saliency) or slowed down (L=low saliency).
- The levels of all independent variables should be factorially combined, The total number of experimental conditions is equal to 2^n.

(Fific, 2014), Frontiers, Accepted

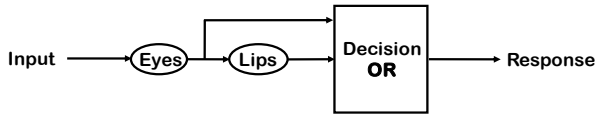
A catalog of mental architectures

Signatures

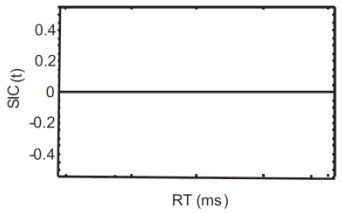
SIC

Architecture flow diagram

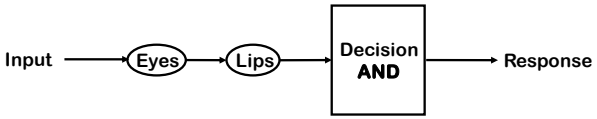
A
Serial
Self-terminating



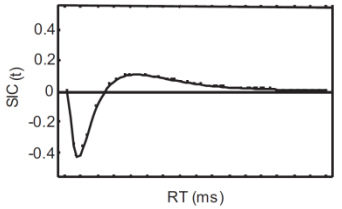
Analytic



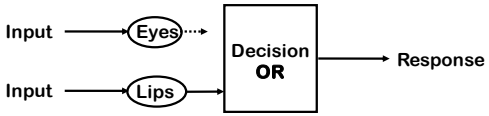
B
Serial
Exhaustive



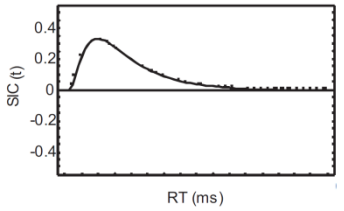
Analytic/ Holistic



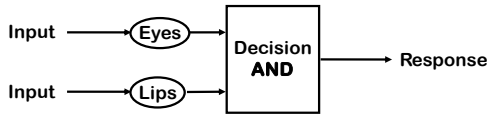
C
Parallel
Self-terminating



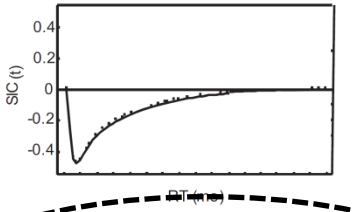
Analytic



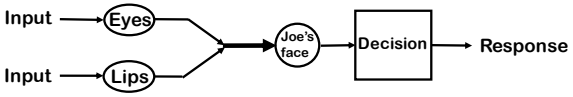
D
Parallel
Exhaustive



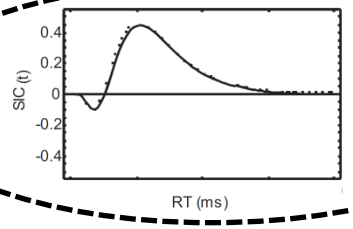
Analytic/ Holistic



E
Coactive

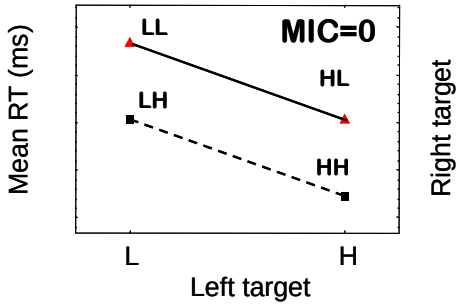


Strong Holistic

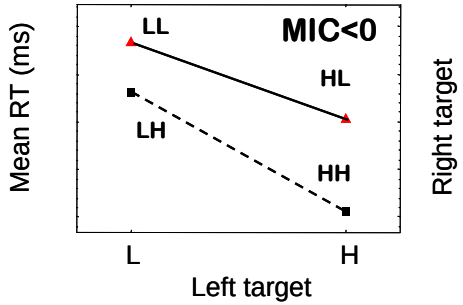


Diagnostic SFT signatures:
MEAN INTERACTION CONTRAST:

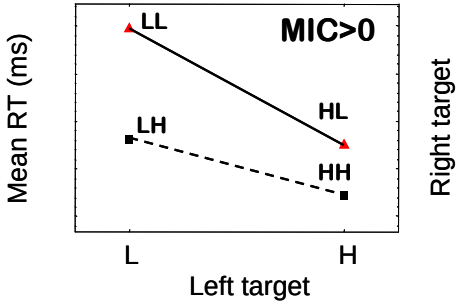
MIC = [RT(LL) - RT(LH)] - [RT(HL) - RT(HH)]



Additive



Under-additive

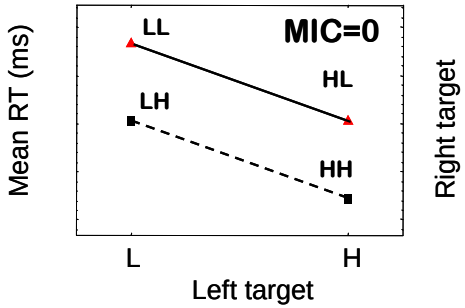


Over-additive

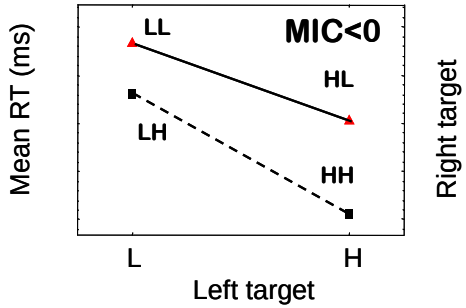
Diagnostic SFT signatures:
MEAN INTERACTION CONTRAST:

MIC = [RT(LL) - RT(LH)] - [RT(HL) - RT(HH)]

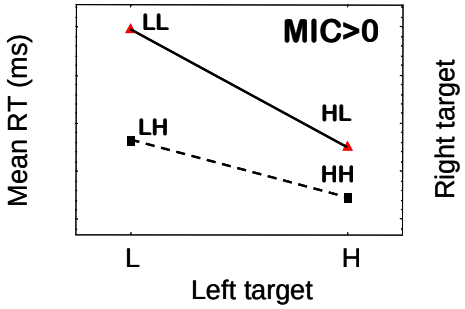
Architecture	Stopping Rule	MIC
Serial	Self Terminating	0, Additive
Serial	Exhaustive	0, Additive
Parallel	Self Terminating	> 0, Overadditive
Parallel	Exhaustive	< 0, Underadditive
Coactive		> 0, Overadditive



Additive



Under-additive



Over-additive

Diagnostic SFT signatures: **SURVIVOR-INTERACTION CONTRAST** (SIC) FUNCTION

$$SIC(t) = [S_{LL}(t) - S_{LH}(t)] - [S_{HL}(t) - S_{HH}(t)]$$

- Analogous to MIC function:

$$MIC = [RT(LL) - RT(LH)] - [RT(HL) - RT(HH)]$$

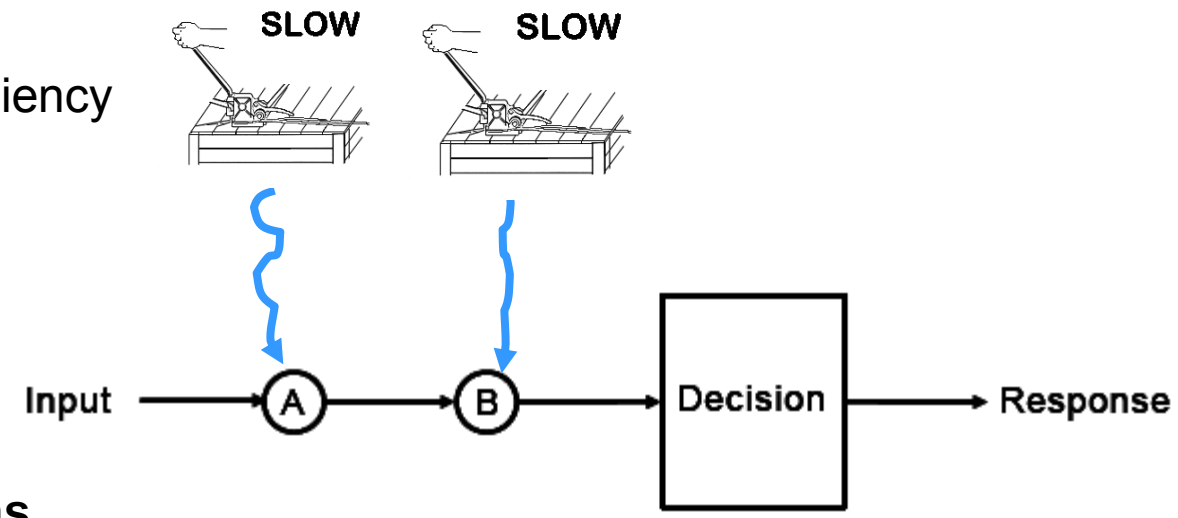
Note:
The integral of the SIC is just the MIC.

SFT

A tutorial about how SFT could be applied on two processes.

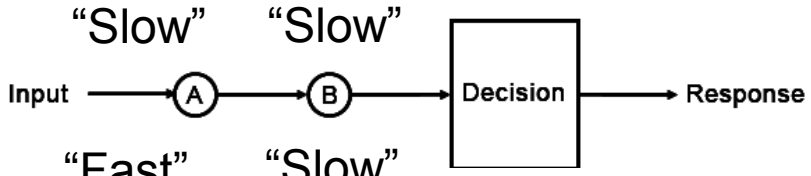
THE FACTORIAL PARADIGM

Experimental control
over the process' saliency

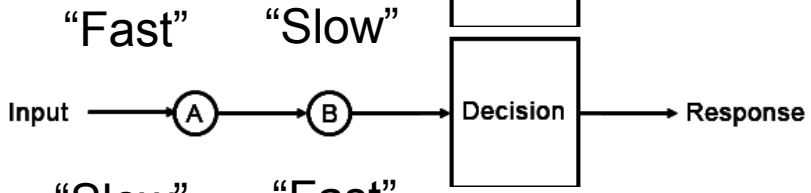


Factorial Conditions

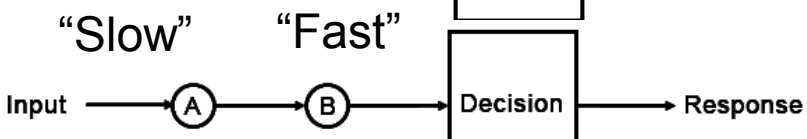
LL



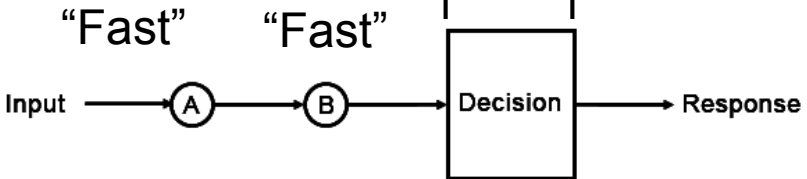
HL



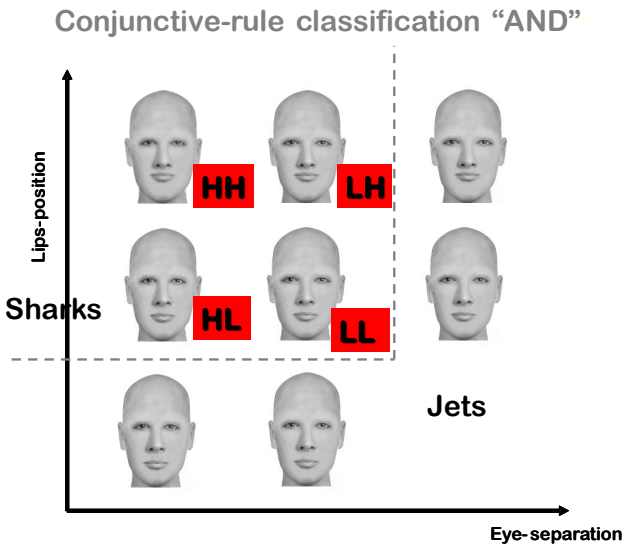
LH



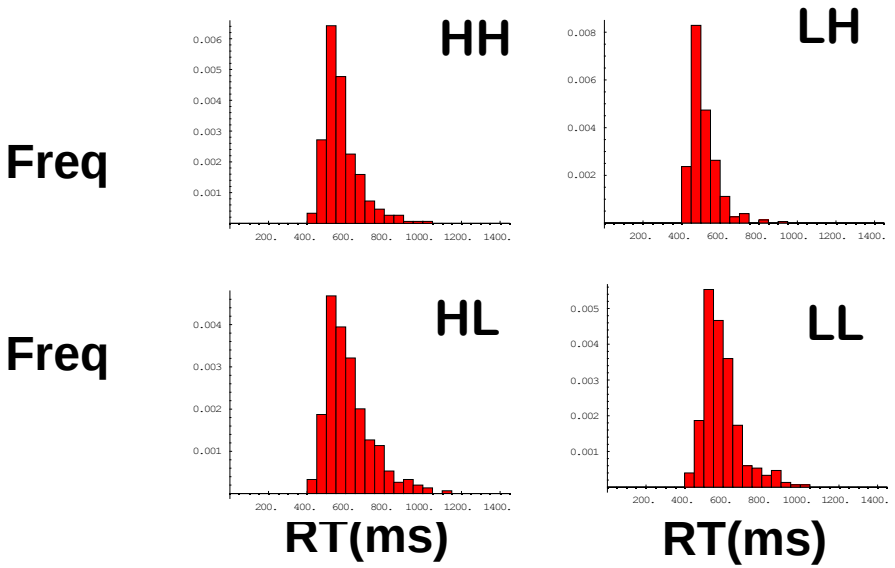
HH



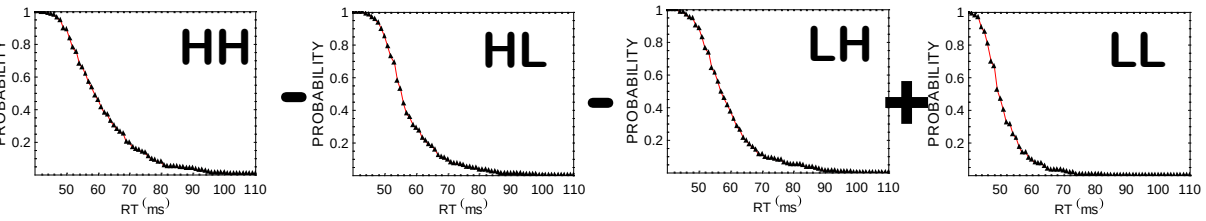
Tutorial: how to calculate the survivor interaction contrast (SIC) function



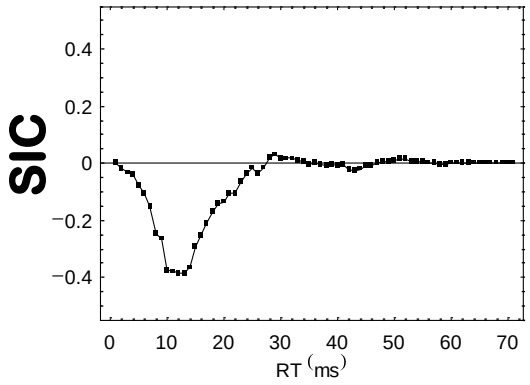
Reaction time histograms



Reaction time Survivor functions



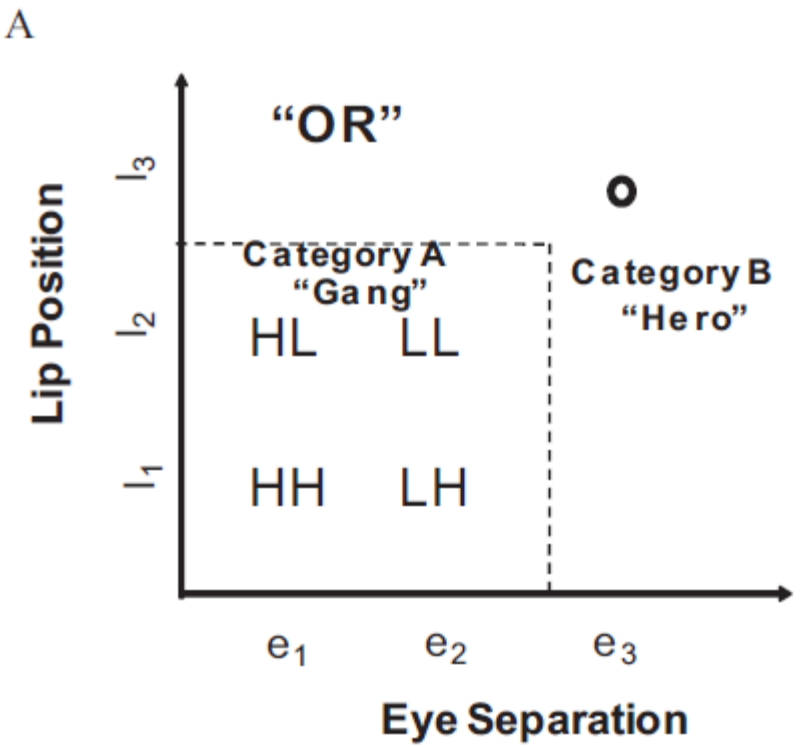
$$SIC(t) = S_{hh}(t) - S_{hl}(t) - (S_{lh}(t) - S_{ll}(t))$$

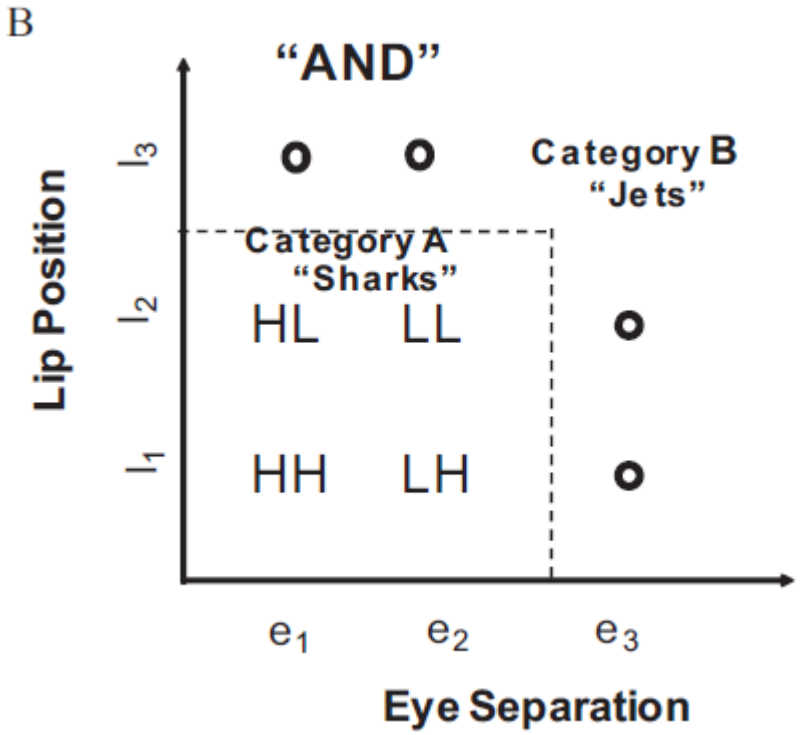


SFT applied on facial features

- SFT approach could be applied on (facial) features varying on continuous stimulus dimensions
- Example: Configural second-order facial features, such as eye separation, or nose position
- The disjunctive and conjunctive-rule stimulus structures, so called OR and AND designs.

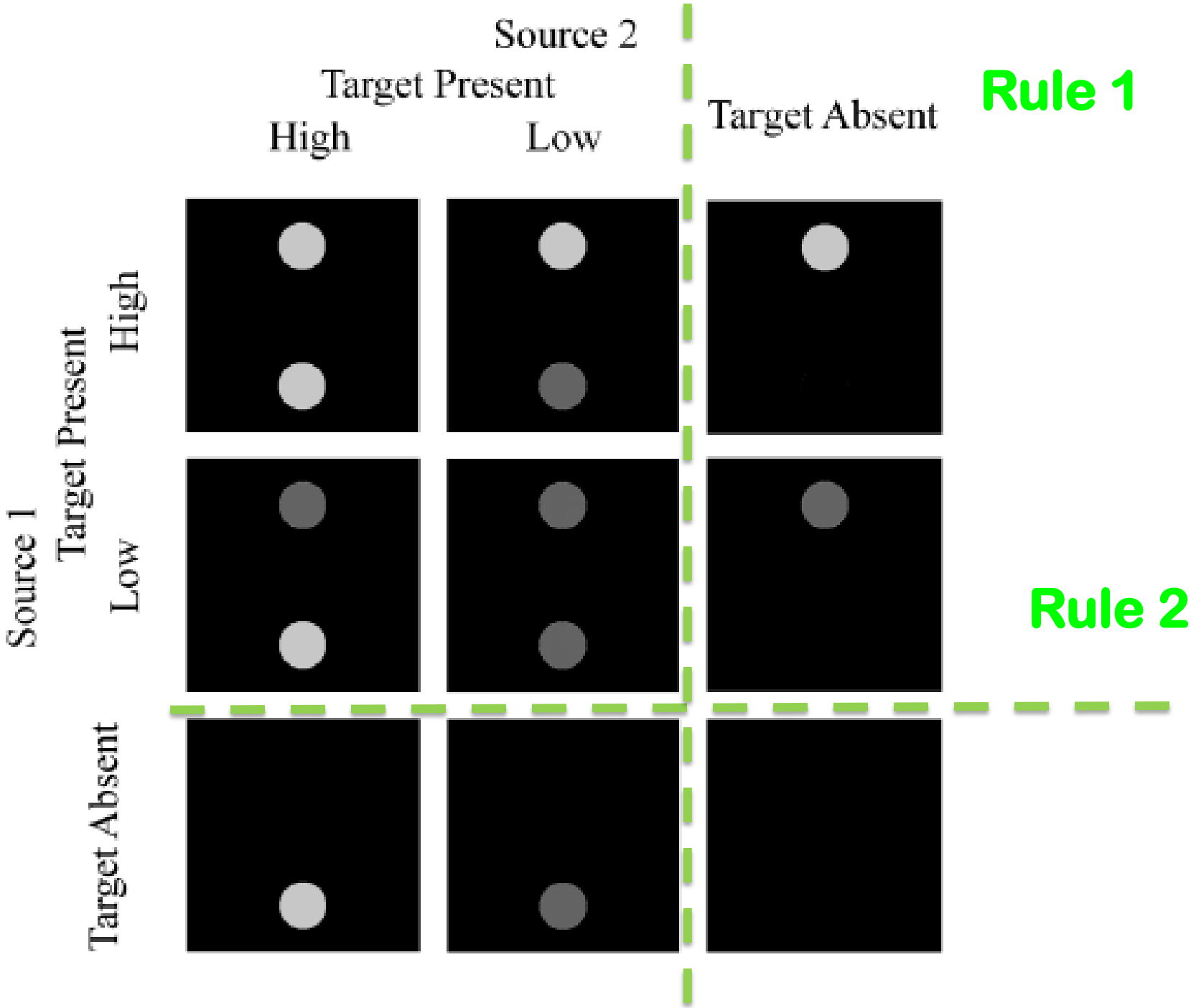
Disjunctive and conjunctive-rule stimulus structures

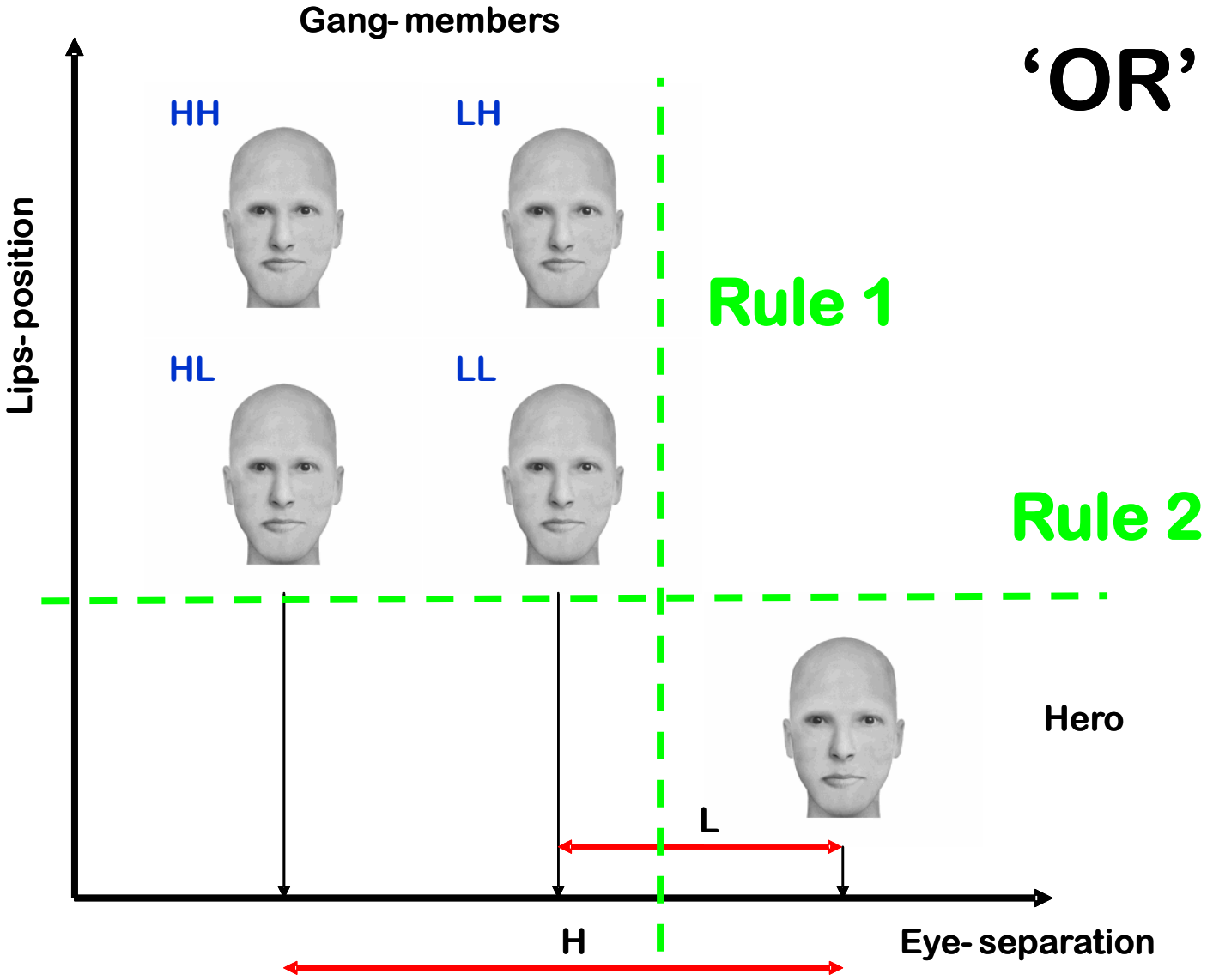




"Analytic friendly"
(permits early termination in processing)

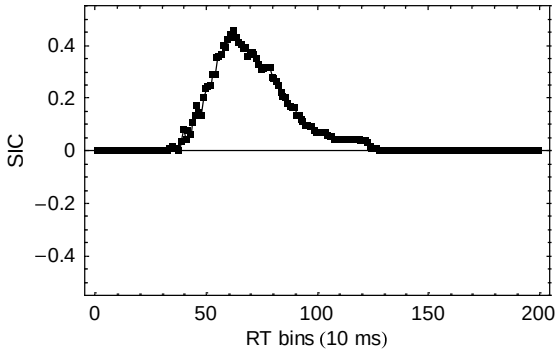
"Holistic friendly"
(requires exhaustive processing of Sharks)

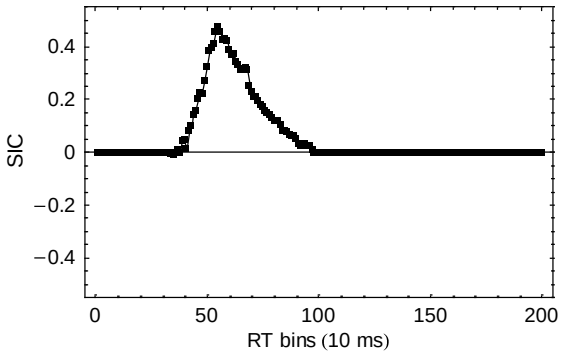

Source 2
Target Present
High
Low
Target Absent
Rule 1
Source 1
Target Present
High
Low
Target Absent
Rule 2

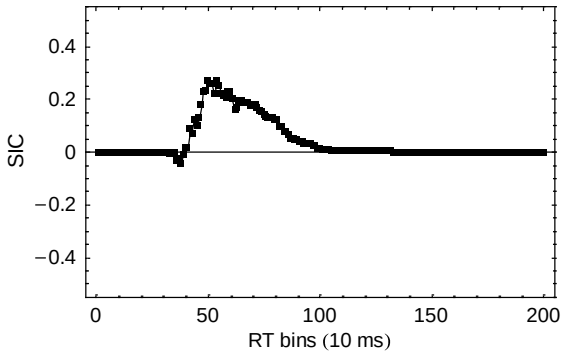

Gang- members
'OR'
HH
LH
HL
LL
Rule 1
Rule 2
Lips- position
Hero
L
H
Eye- separation

Disjunctive-rule stimulus structures

Observed SIC signatures







A catalog of mental architectures

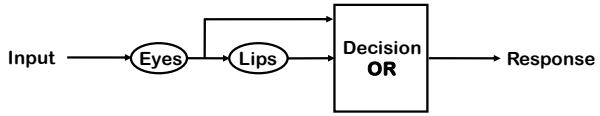
Architecture flow diagram

Signatures

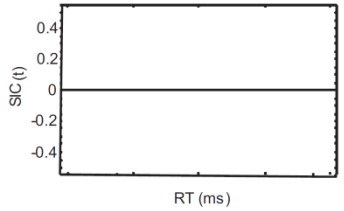
SIC

A

Serial
Self-terminating

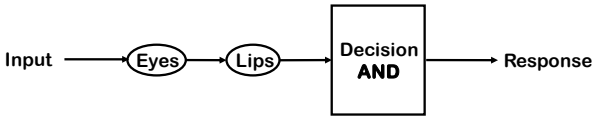


Analytic

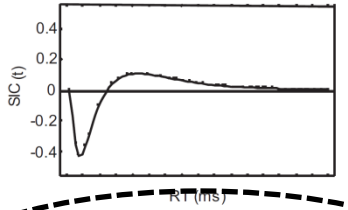


B

Serial
Exhaustive

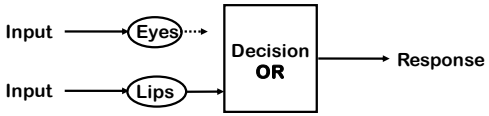


Analytic/ Holistic

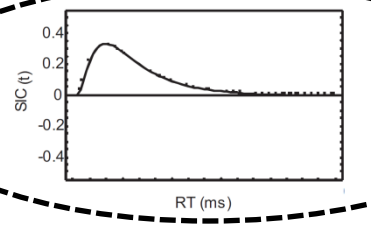


C

Parallel
Self-terminating

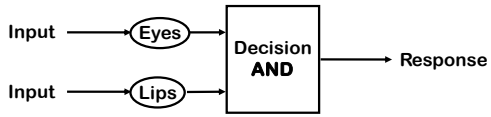


Analytic

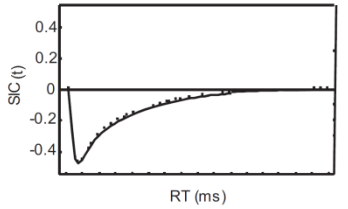


D

Parallel
Exhaustive

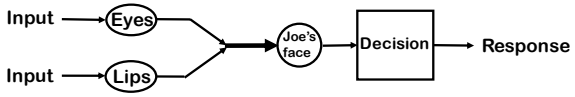


Analytic/ Holistic

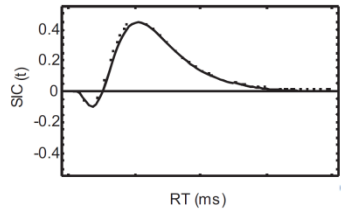


E

Coactive

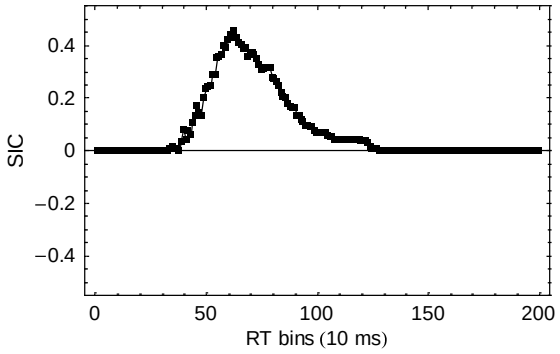


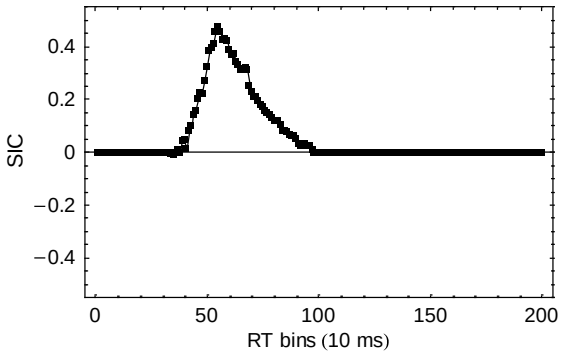
Strong Holistic

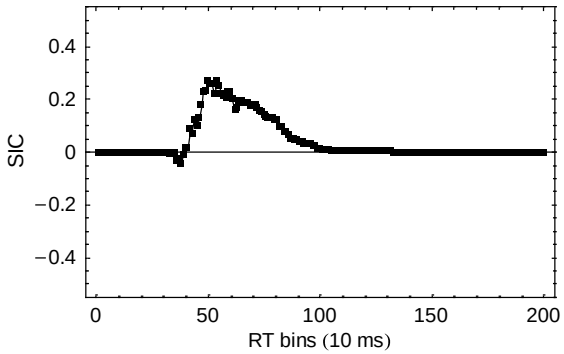


“OR” Disjunctive-rule stimulus structures

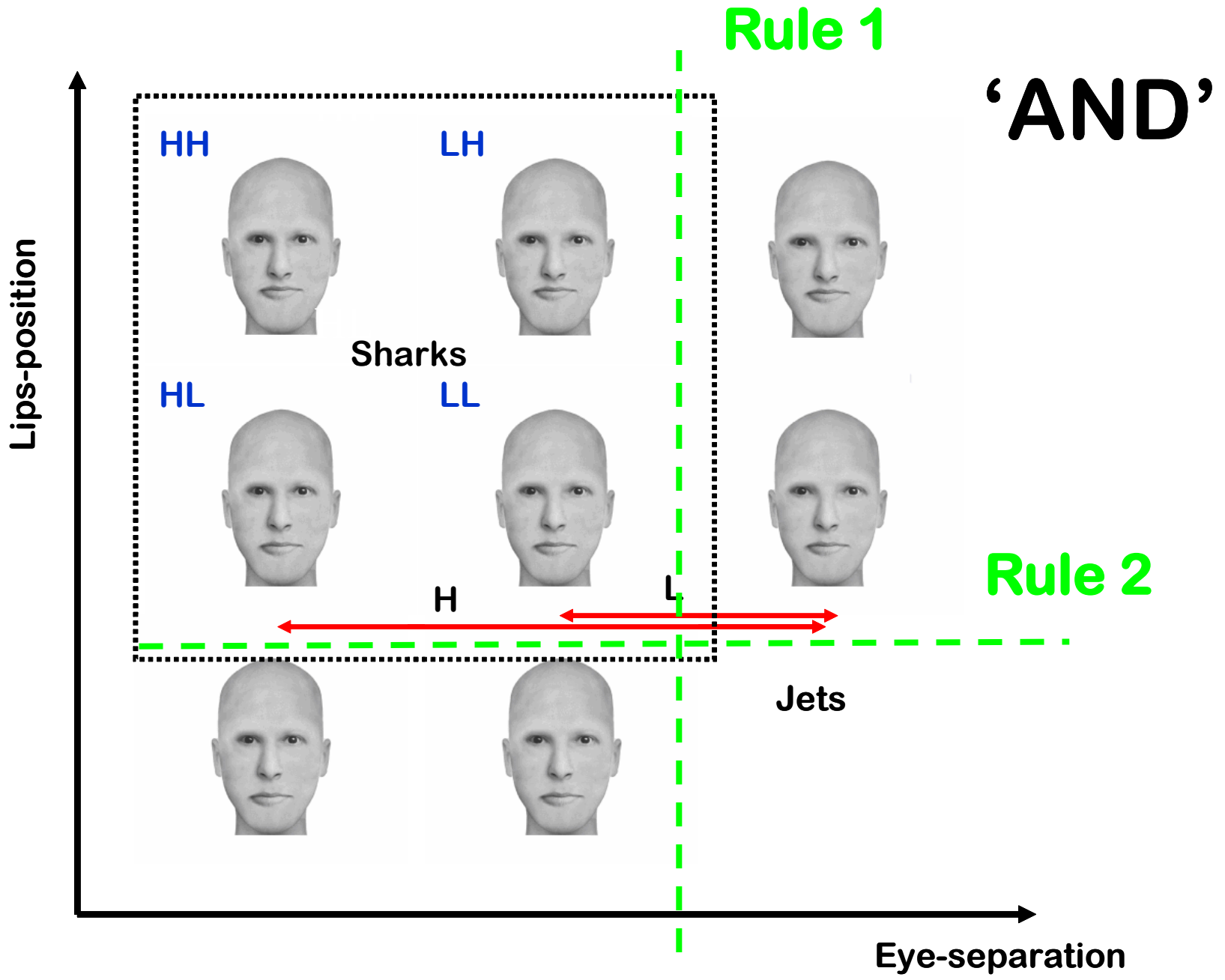
Observed SIC signatures







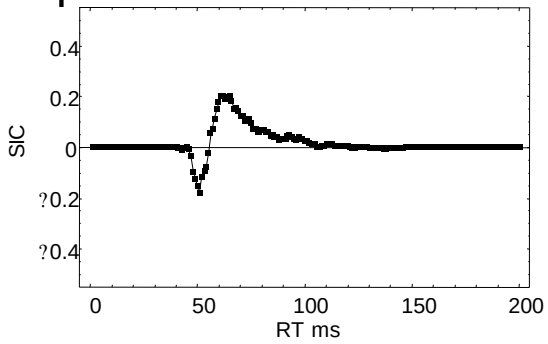
Conclusion: A parallel self-terminating mental architecture


Rule 1
'AND'
HH
LH
Sharks
HL
LL
H
L
Rule 2
Jets
Lips-position
Eye-separation

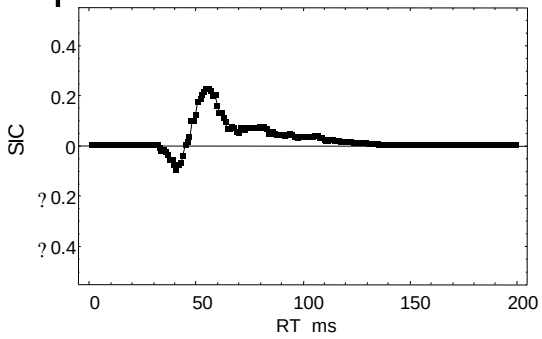
“AND” Conjunctive-rule stimulus structures

Observed SIC signatures

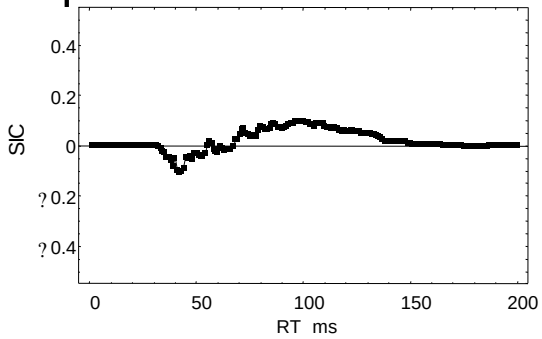
Participant 1



Participant 2



Participant 3



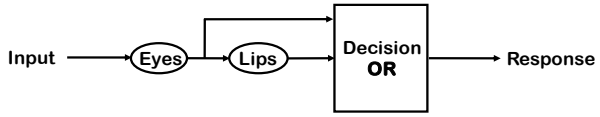
A catalog of mental architectures

Signatures

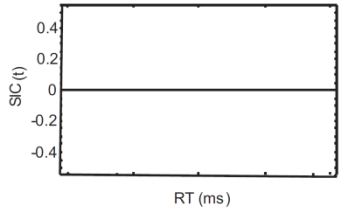
SIC

Architecture flow diagram

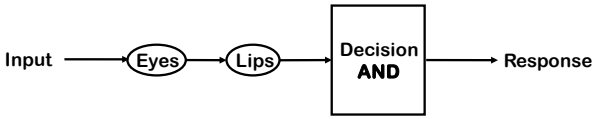
A
Serial Self-terminating



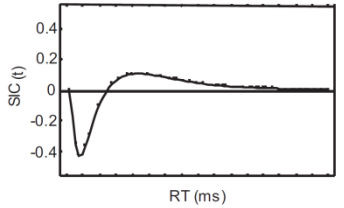
Analytic



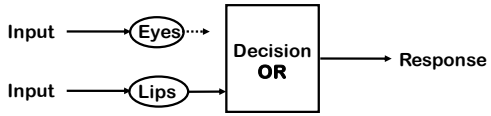
B
Serial Exhaustive



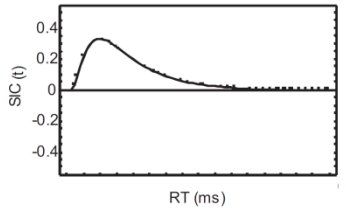
Analytic/ Holistic



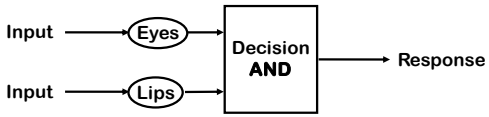
C
Parallel Self-terminating



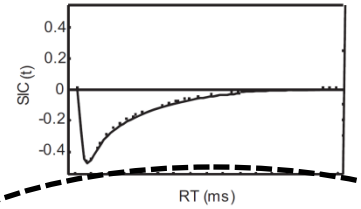
Analytic



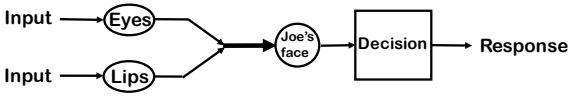
D
Parallel Exhaustive



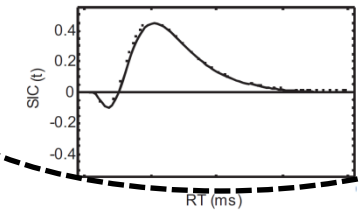
Analytic/ Holistic



E
Coactive



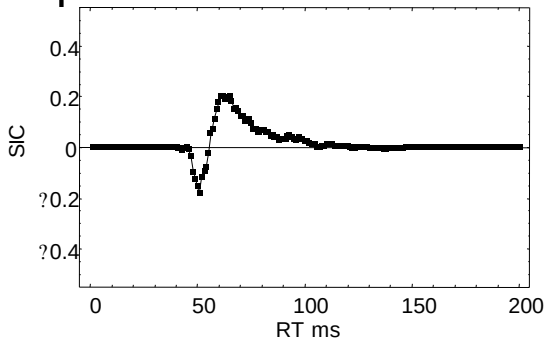
Strong Holistic



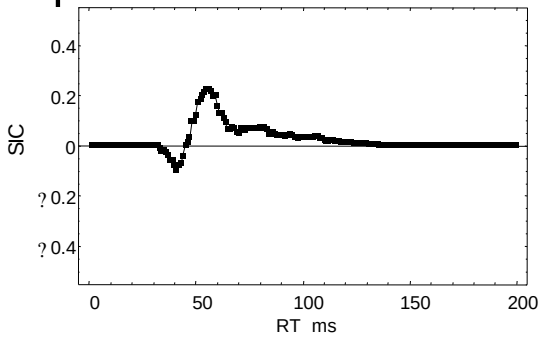
“AND” Conjunctive-rule stimulus structures

Observed SIC signatures

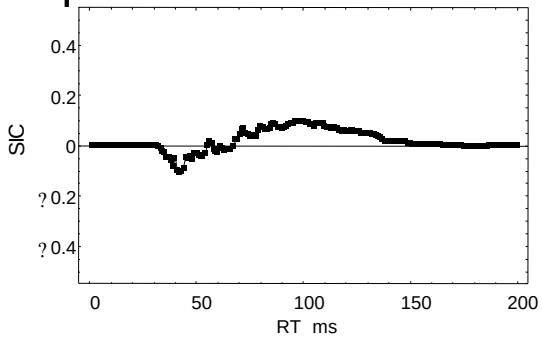
Participant 1



Participant 2

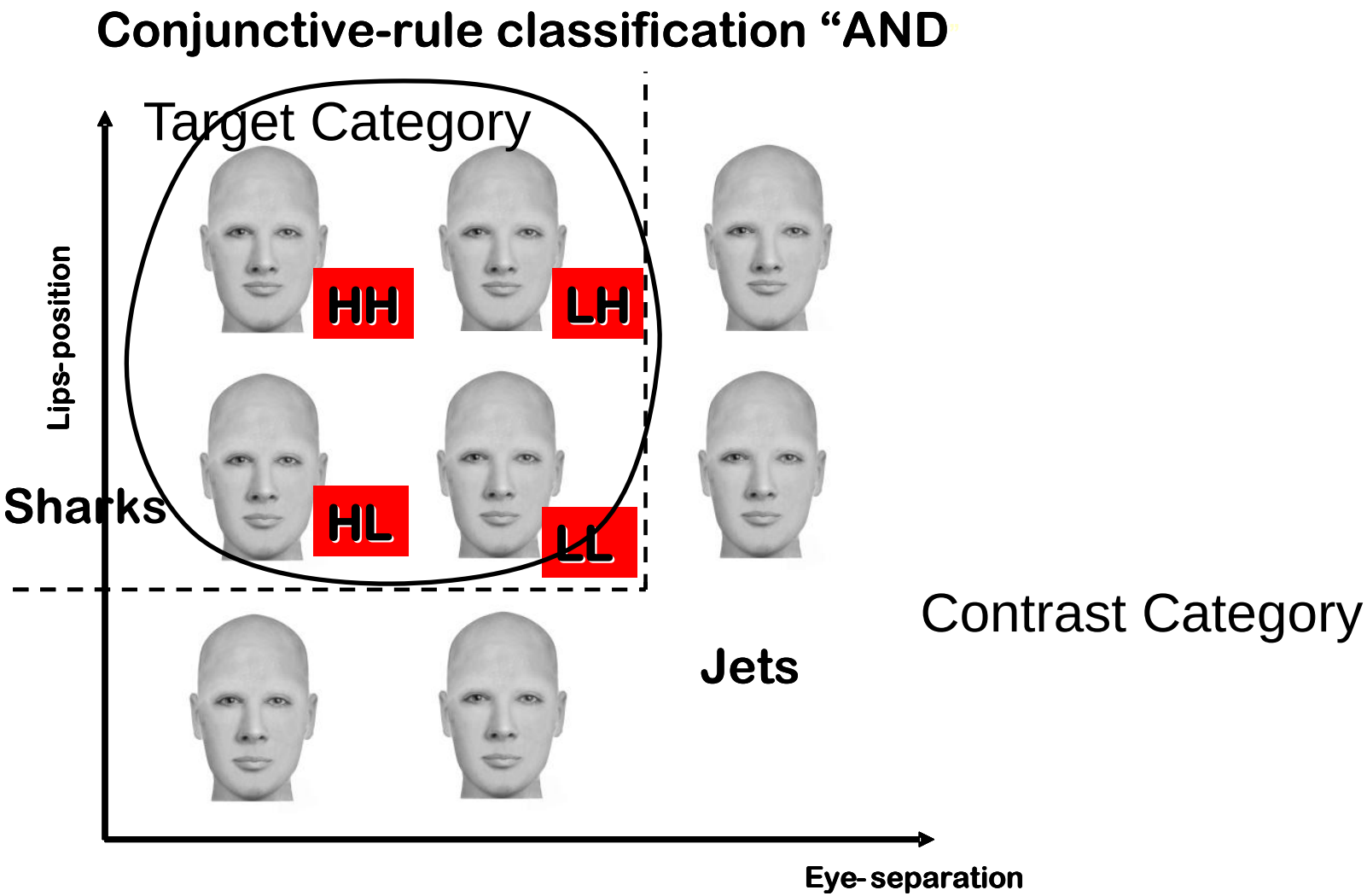


Participant 3



Conclusion: A coactive mental architecture

The task

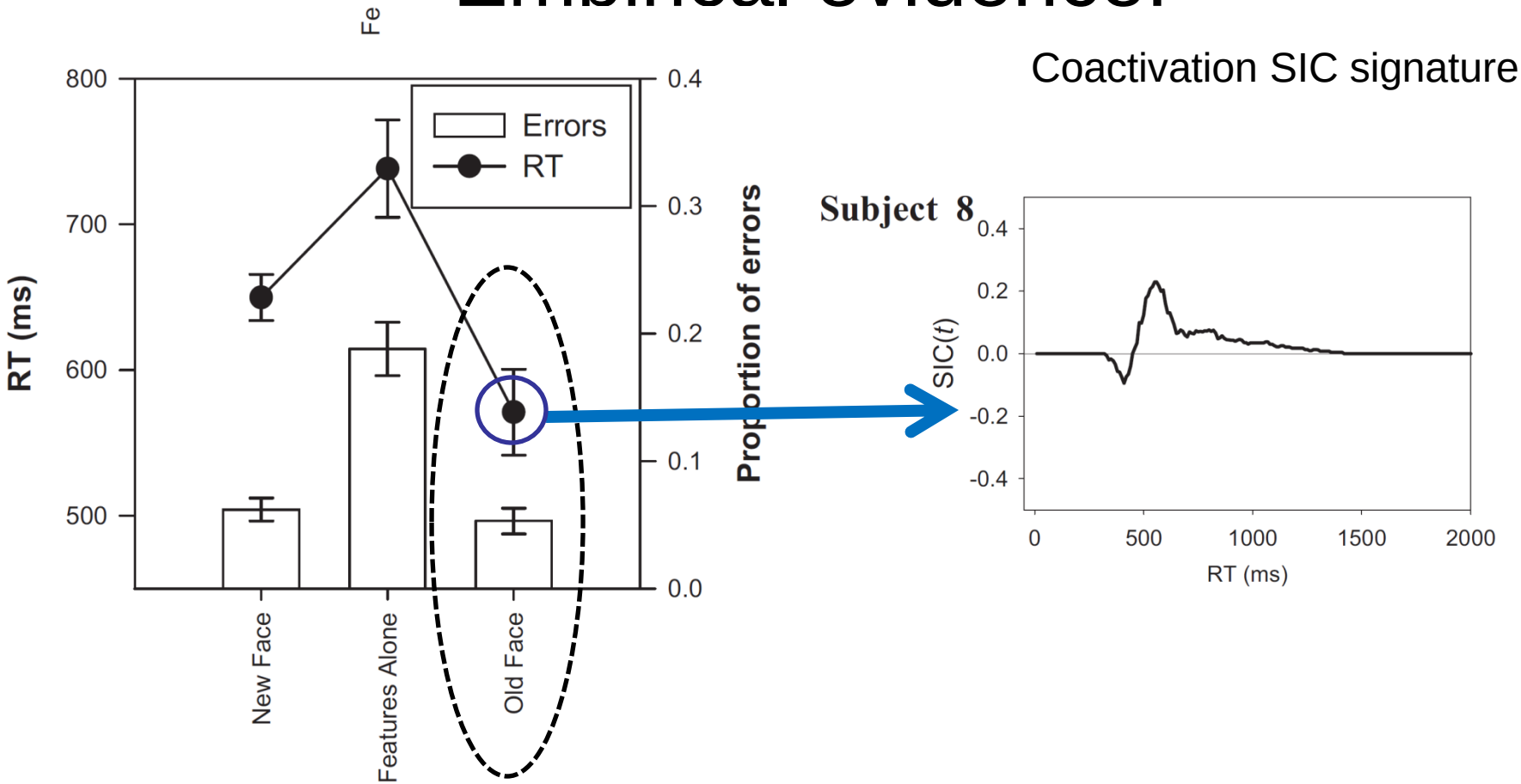


(Fific & Townsend, 2010)

Signatures of Holistic perception

- Gestalt laws: proximity similarity by inducing perceptual effects (Sarris; Overvliet, Krampe & Wagemans)
- Pop-out effect (Pomerantz; Eidels)
- Part to whole paradigm (Donnelli; Tanaka & Farah; Bierman)
- Garner Task (Kimchi)
- Superiority effects (Pomerantz)
- Thatcher faces illusion: Grotesqueness (Wenger)
- Face inversion (Bartlett, Innes-Ker)
- Unitization (Goldstone, Lightfoot & Shiffrin, Blaha
- Scrambled faces vs Normal
- Neural Responses (Peterson, Palmeri)
- Context effect (Palmer, Kimchi)
- **Super capacity index** (Townsend, Eidels, Blaha, Little)
- **Coactivation signature** (Colonius, Little, Fific, Nosofsky, Townsend; Houpt)

Part-to-whole paradigm x SFT x AND design
Empirical evidence:



Coactivation SIC signature

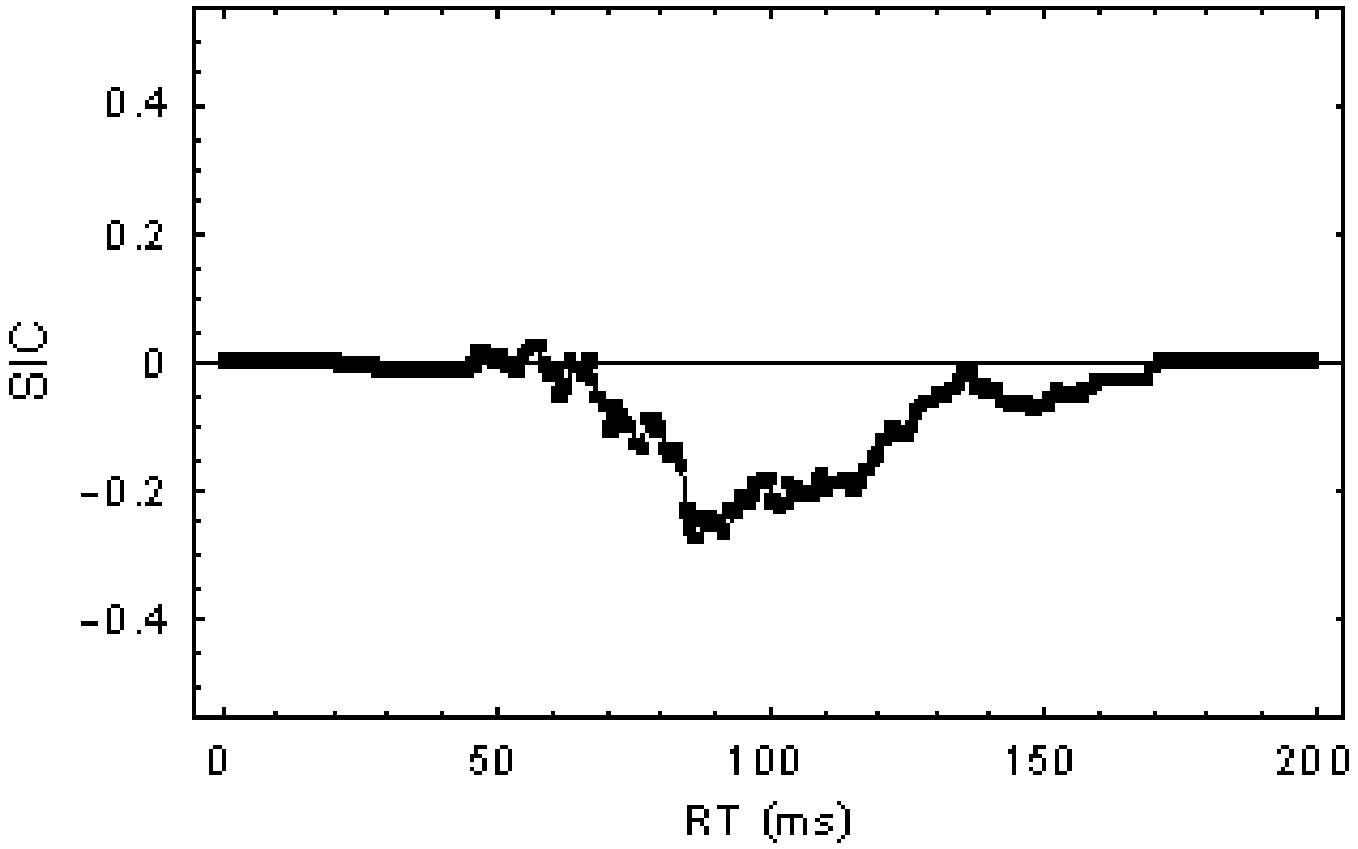
(Fific & Townsend, 2010)

- Can we provide a strong validation of such signature?

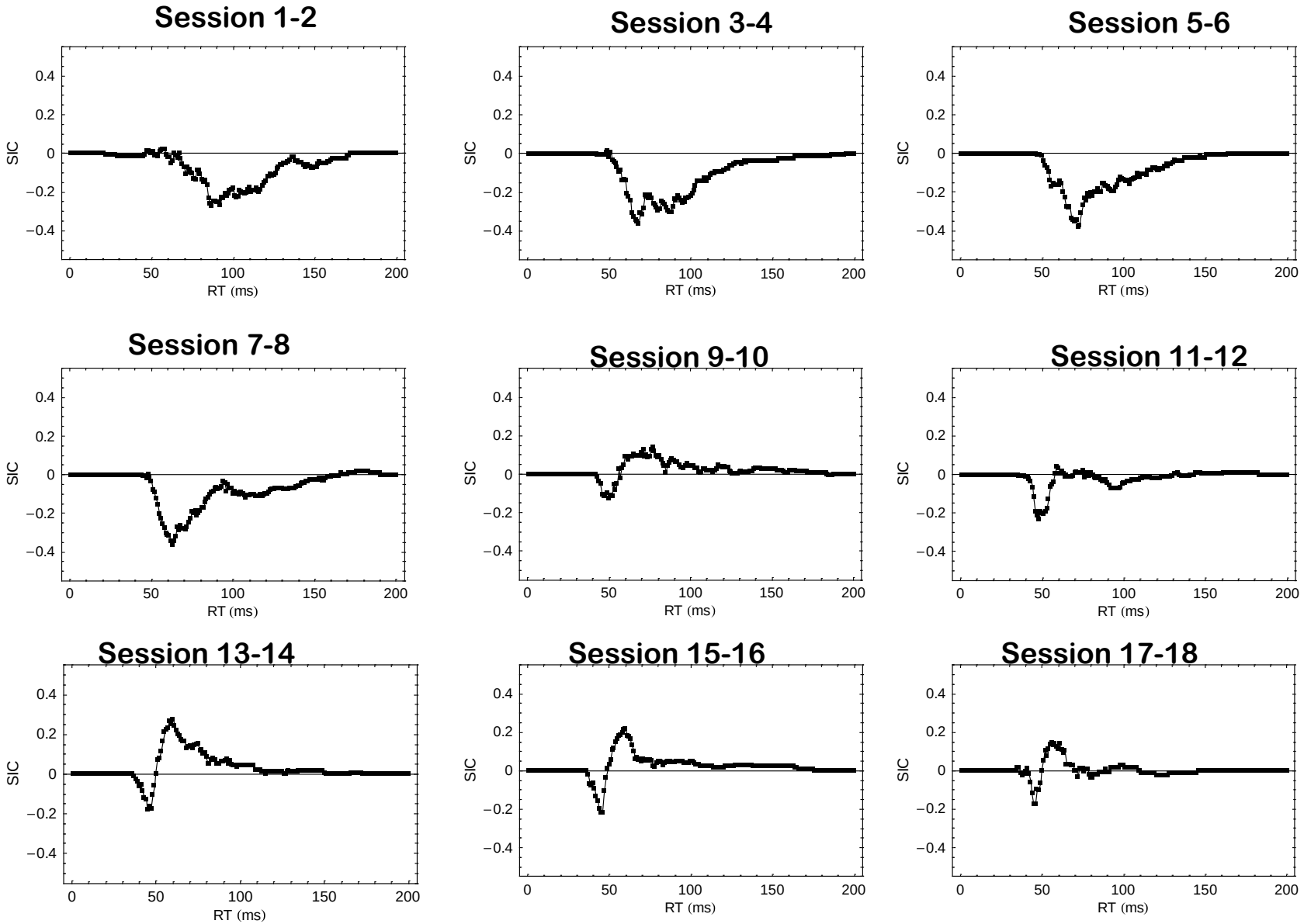
New signature of holistic perception

- Dynamical SIC signature

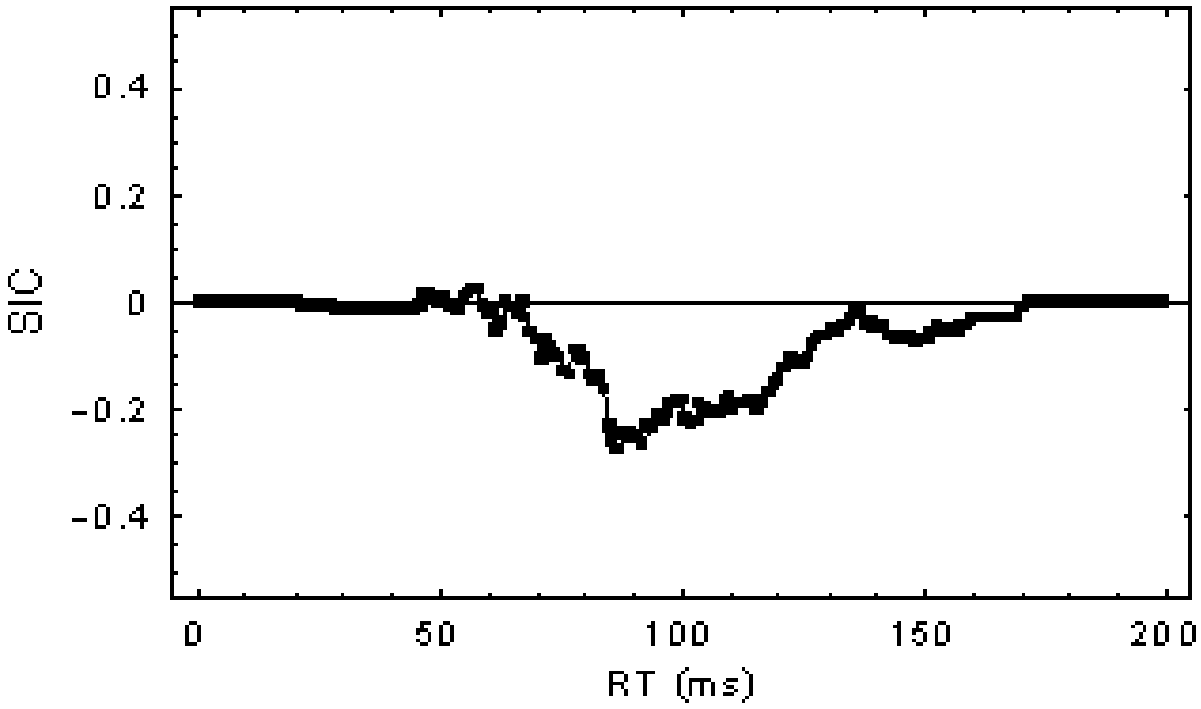
The signature “Snake Wiggle”



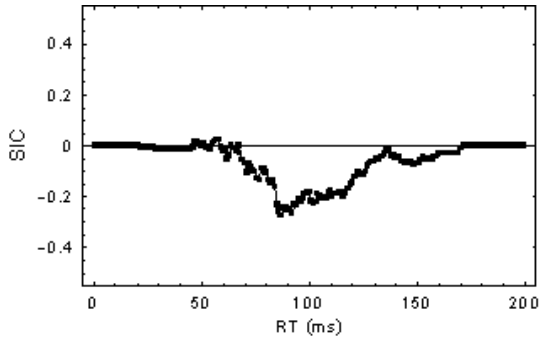
The “Snake Wiggle” signature



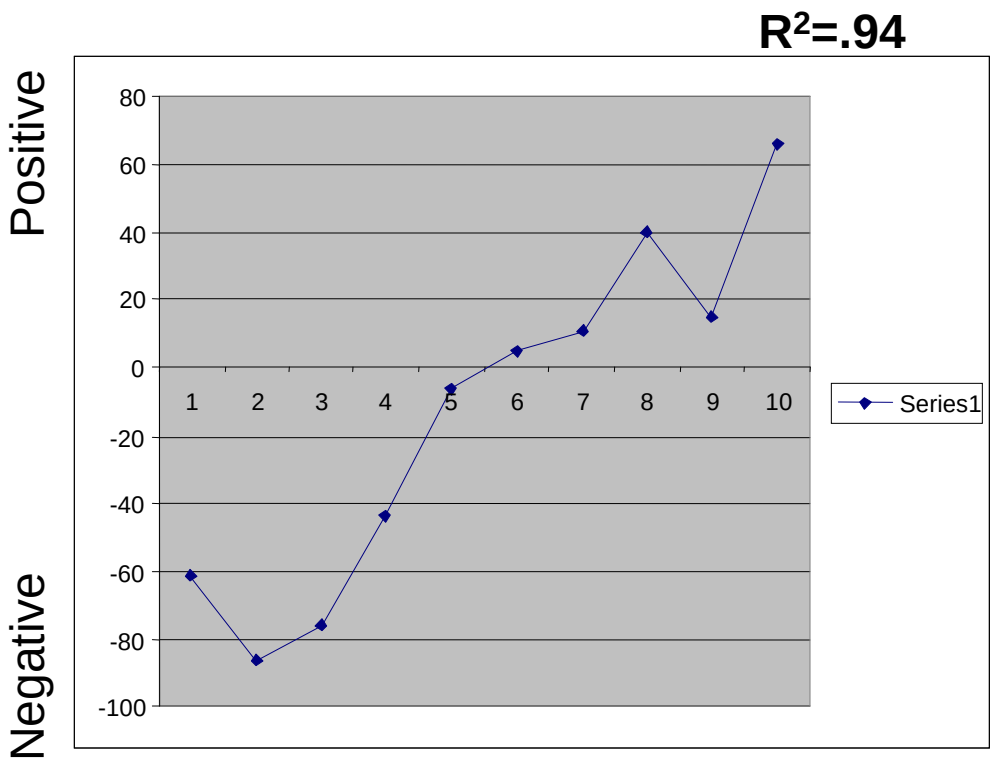
The signature “Snake Wiggle”



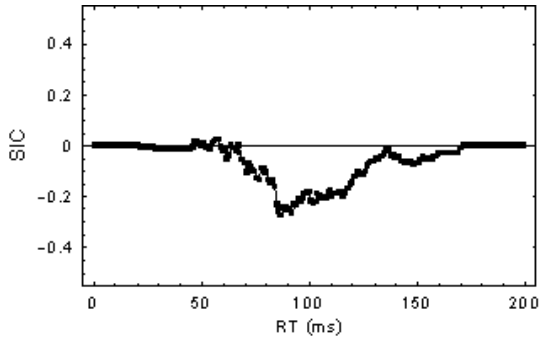
The signature “Snake Wiggle”



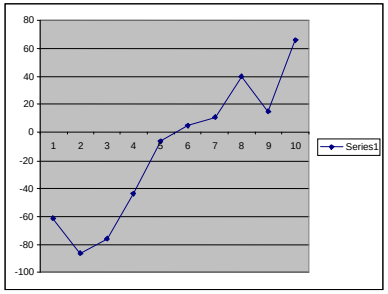
The total area under the curve



The signature “Snake Wiggle”

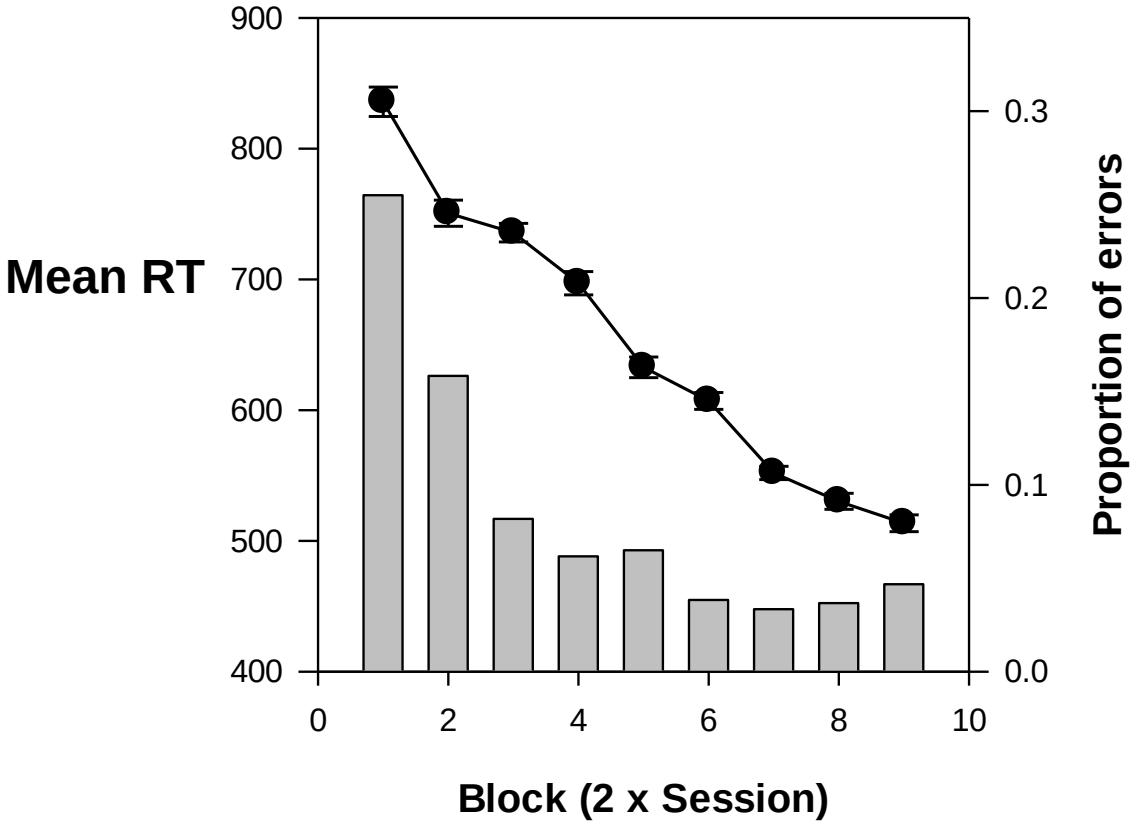


The sum of the area under the curve



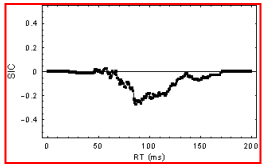
Sessions

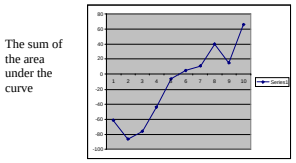
Mean RT trend

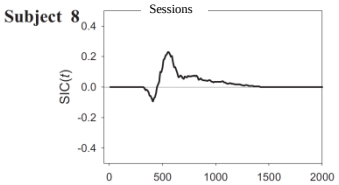


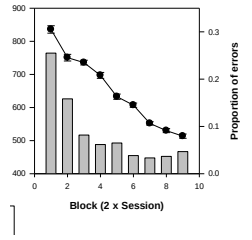
The converging evidence toward holistic processing

- **Let's wiggle**: The SIC function wiggles its way to S-shaped positive function
- **Robustness**: All subjects wiggled
- **Coactivation**: The target signature is Coactive, an indicator of strong holism
- **Performance superiority**: Mean RT decreases, and accuracy improves (superior performance)
- **Introspection**: The verbal reports









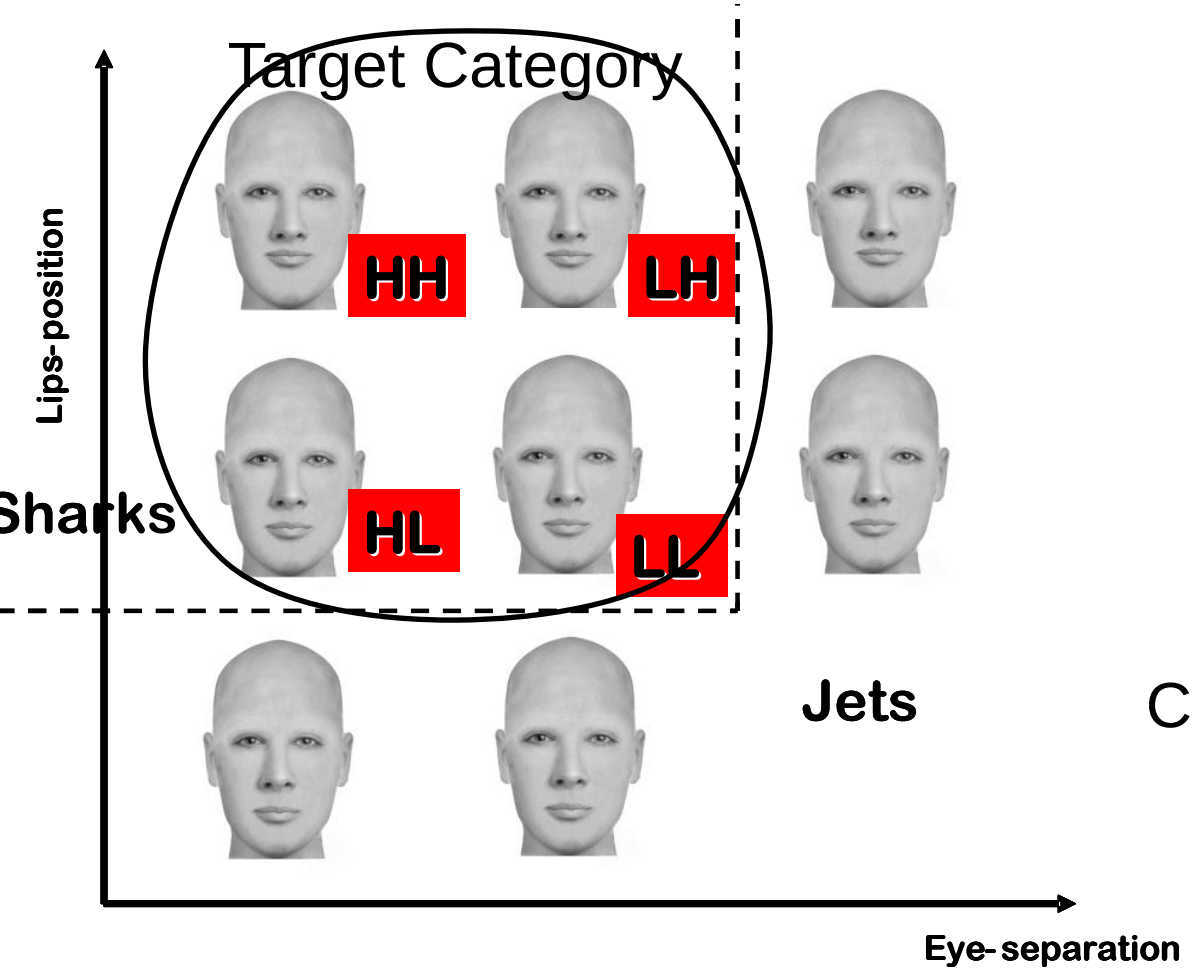
Conclusion

- How strong is the conclusion that a Snake Wiggle signature indicates strong holism?

- Can we make it stronger?

More converging evidence

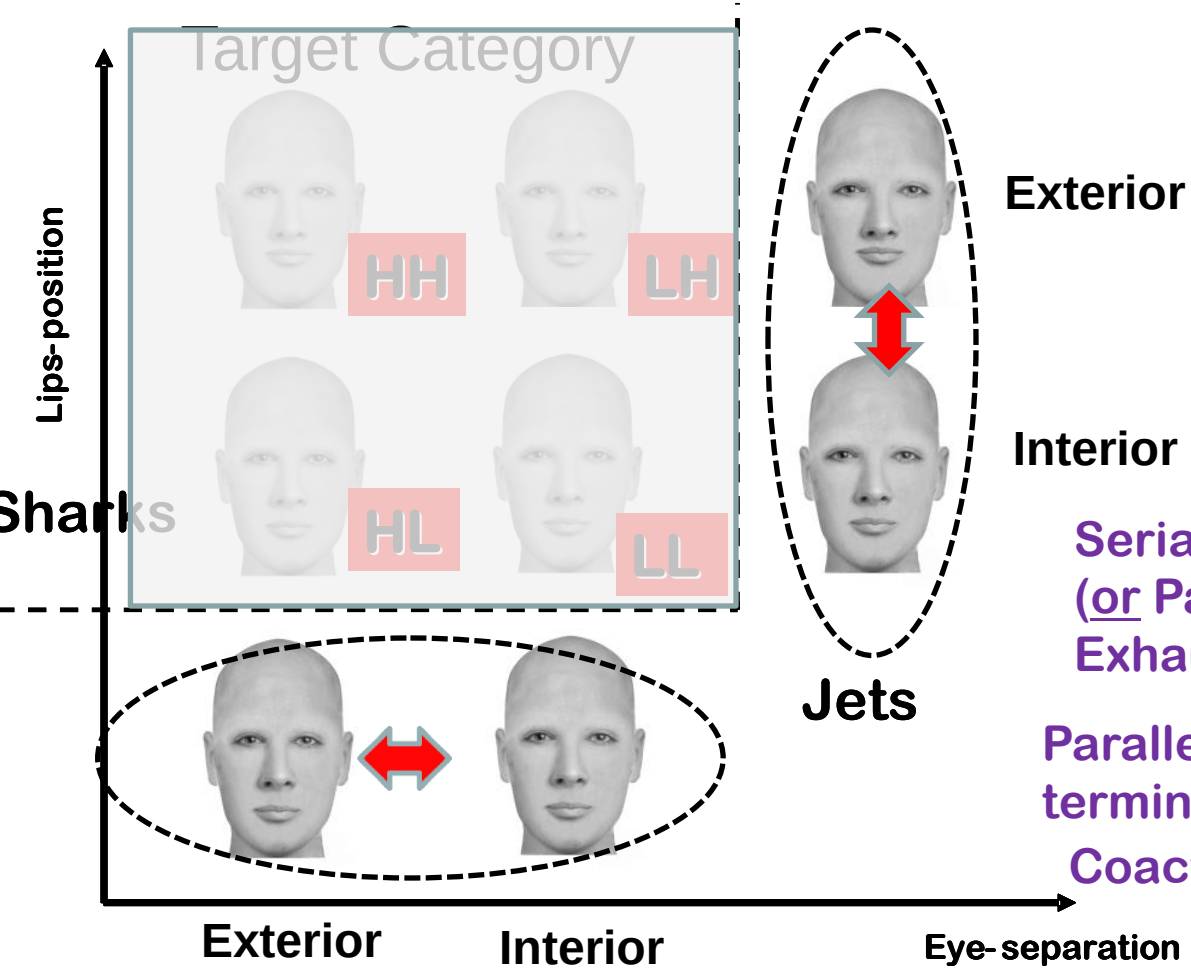
Conjunctive-rule classification "AND"



(Fific & Townsend, 2010)

Converging evidence

Conjunctive-rule classification "AND"



Contrast Category

Serial model (or Parallel Exhaustive) RT[Ext]<RT[Int]

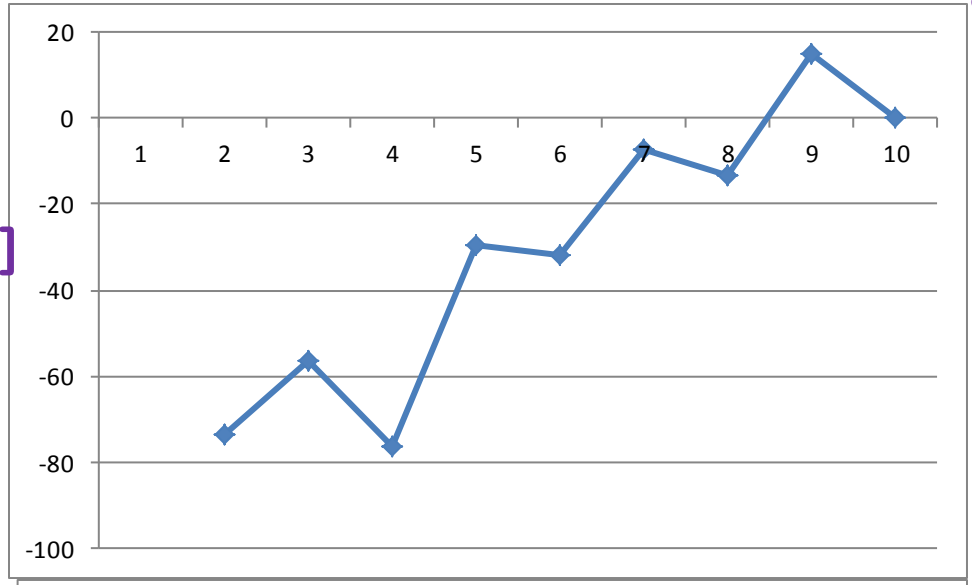
Parallel self-terminating model RT[Ext]=RT[Int]

Coactive RT[Ext]>RT[Int]

(Fific, Little & Nosofsky, 2010; Psych Review)

Converging evidence

RT[Ext]-RT[Int]

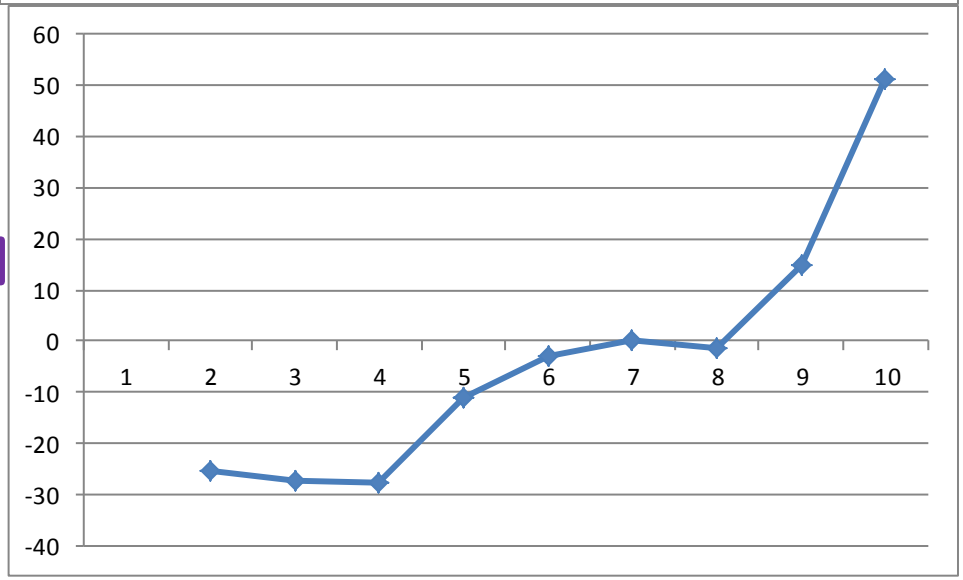


"Coactive"

Snake Wiggle

"Serial or Parallel Exhaustive"

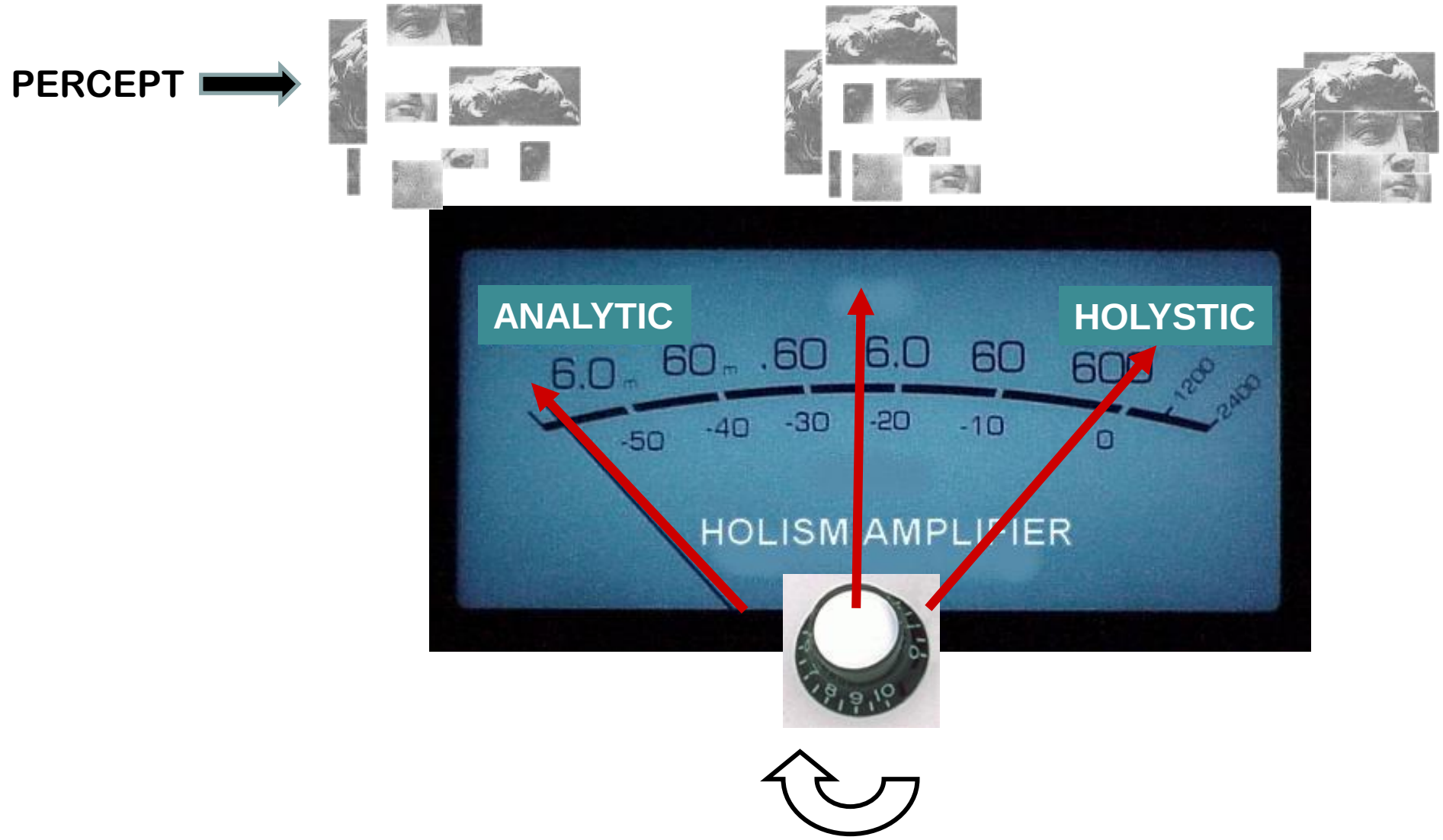
RT[Ext]-RT[Int]



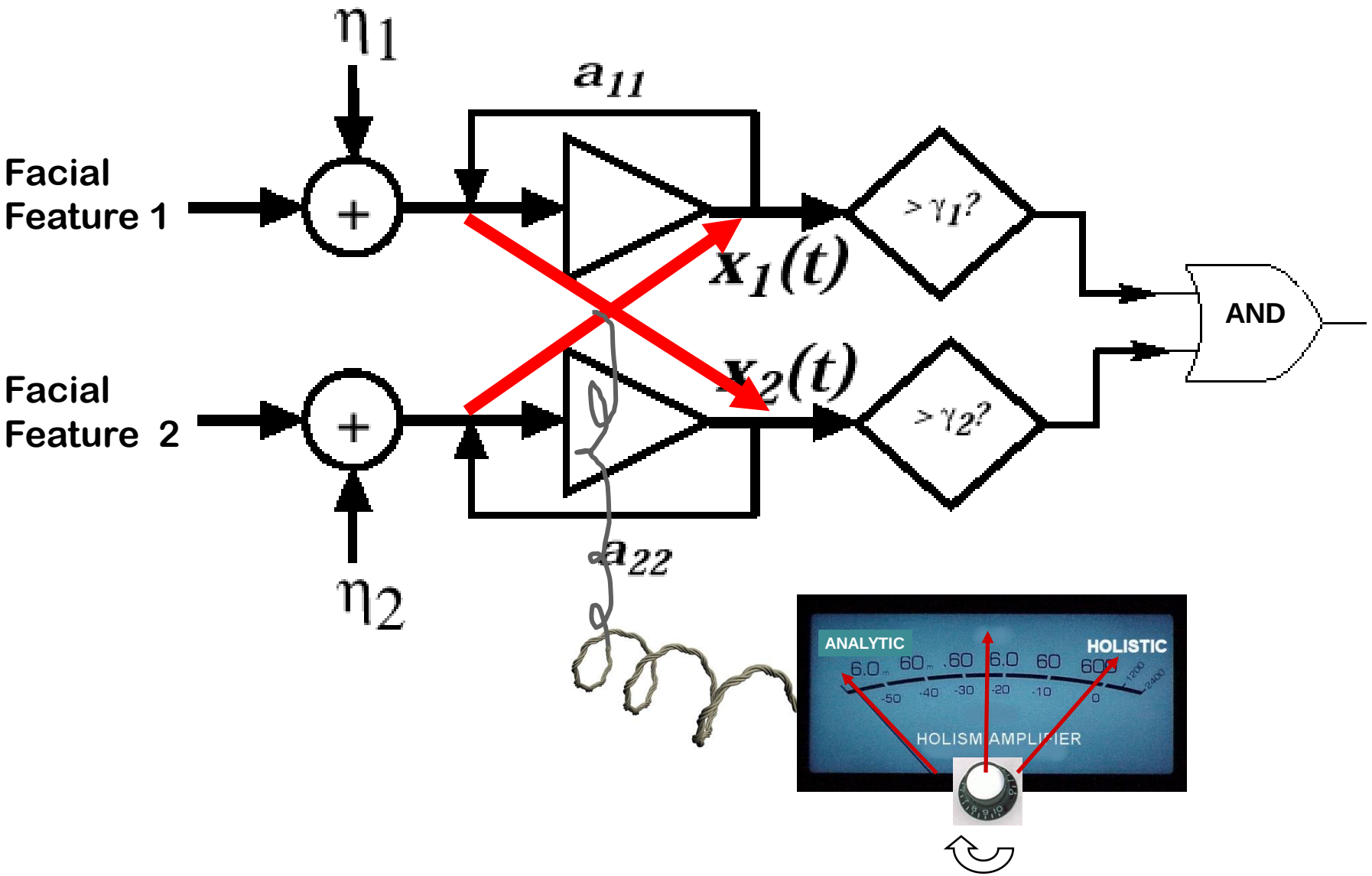
"Coactive"

"Serial or Parallel Exhaustive"

Cognitive control of Analytic/Holistic Perception?



Plausible Model



The snake wiggle

- **The snake wiggle is a dynamic signature of holistic perception**
- **The converging evidence from other sources: superiority, robustness and introspection.**
- **The entire stimulus set wiggles.**
- **Plausible trusted models for dynamical evidence accumulation.** (Houpt & Townsend, 2011; Fific & Townsend, 2010; Eidels, Houpt, Altieri & Townsend, 2011)
- **Let's wiggle.**