

Asynchronous presentation and capacity issue: The ABC of visual search.

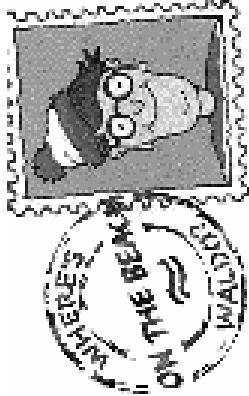


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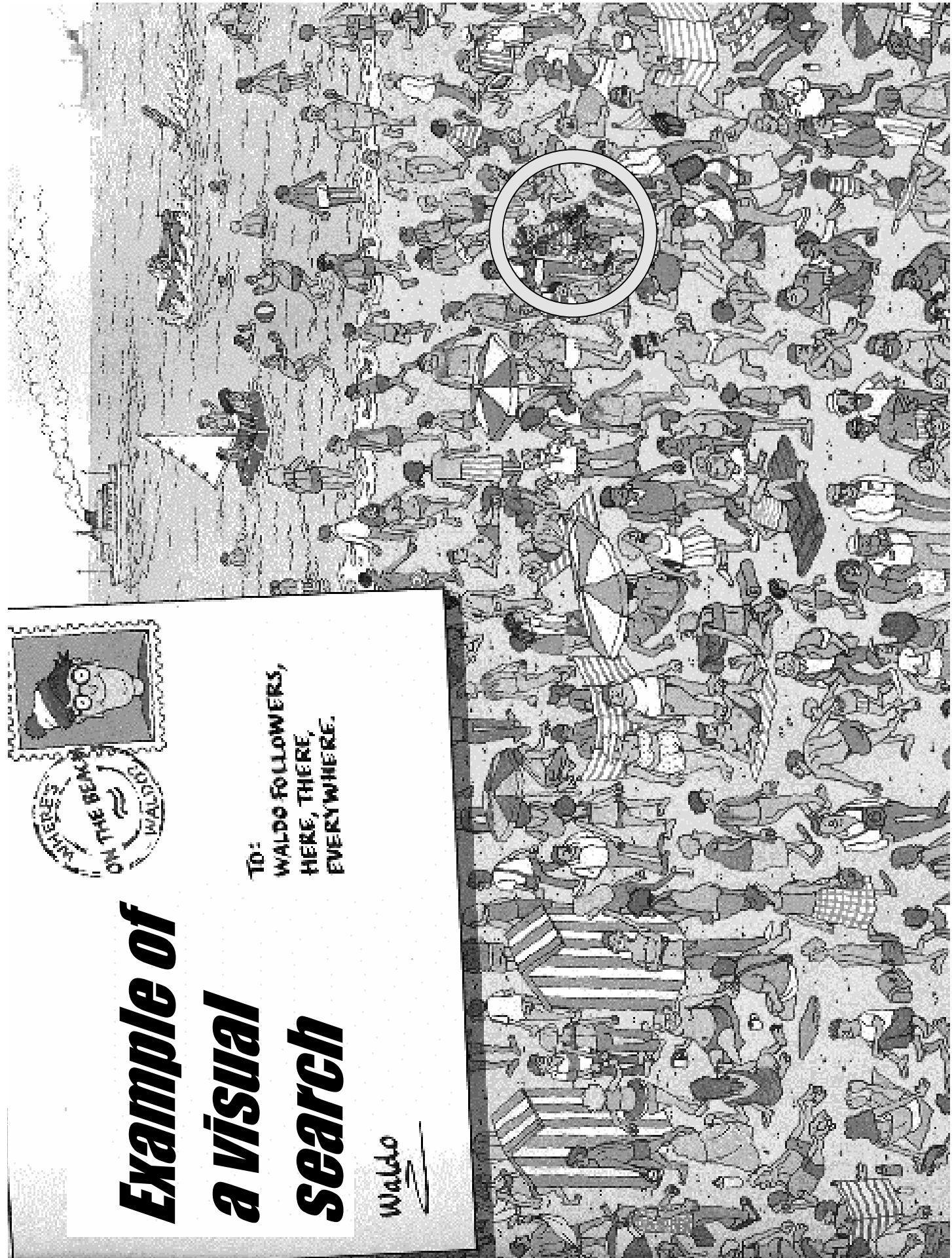
A work in progress...

Example of a Visual Search

Waldo



TO:
WALDO FOLLOWERS,
HERE, THERE,
EVERYWHERE.



Introduction:

Typical questions

Three aspects of performance:

A- Scanning mode

Parallel vs. Serial

B- Stopping rule

Exhaustive vs. Self-terminating

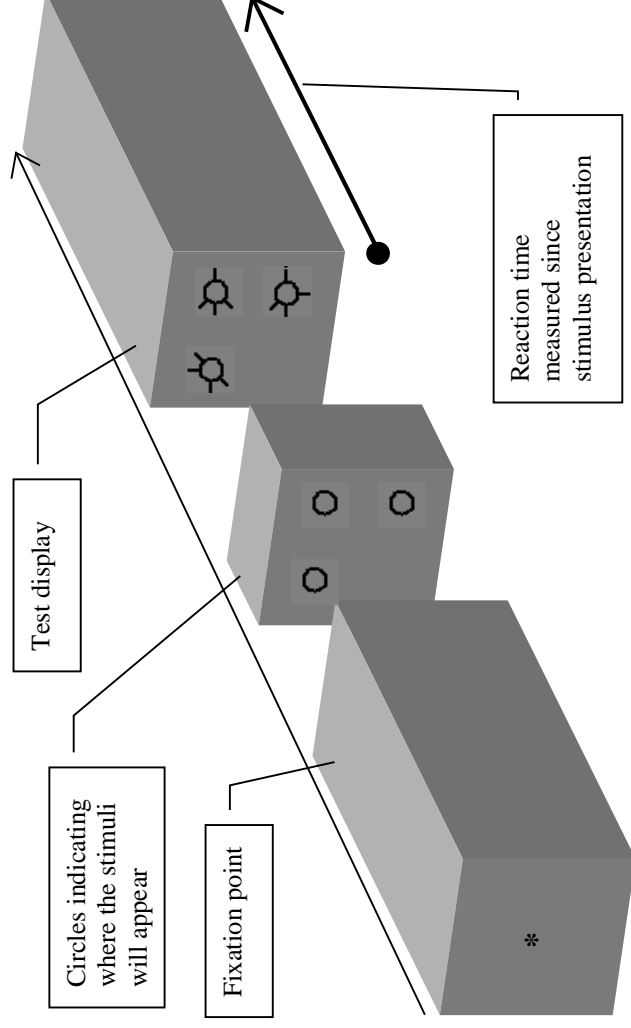
C- Identification process

Unitization vs. Binding

Capacity

Introduction:

Typical task



8 subjects started the experiment

4 finished training [.. session 44]

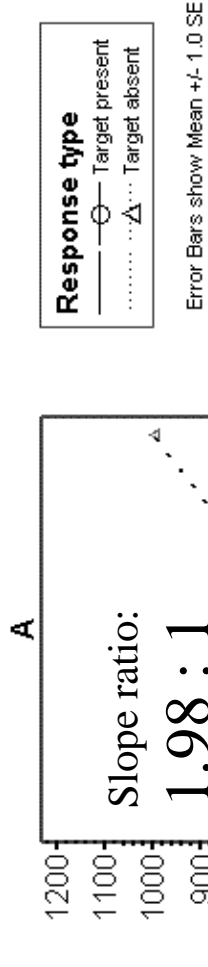
2 finished transfers [.. session 74]

- **The subjects were well-trained (74 hours);**
- **False alarm rate are very low (~1.5%); Miss rate are also low (<5%);**
- **Tested with either 1, 2, or 4 objects, with 1 or no target;**
- **Note that circles indicate where objects will appear.**

Introduction:

Typical results

Mean RT in Standard search as a function of subjects and response type

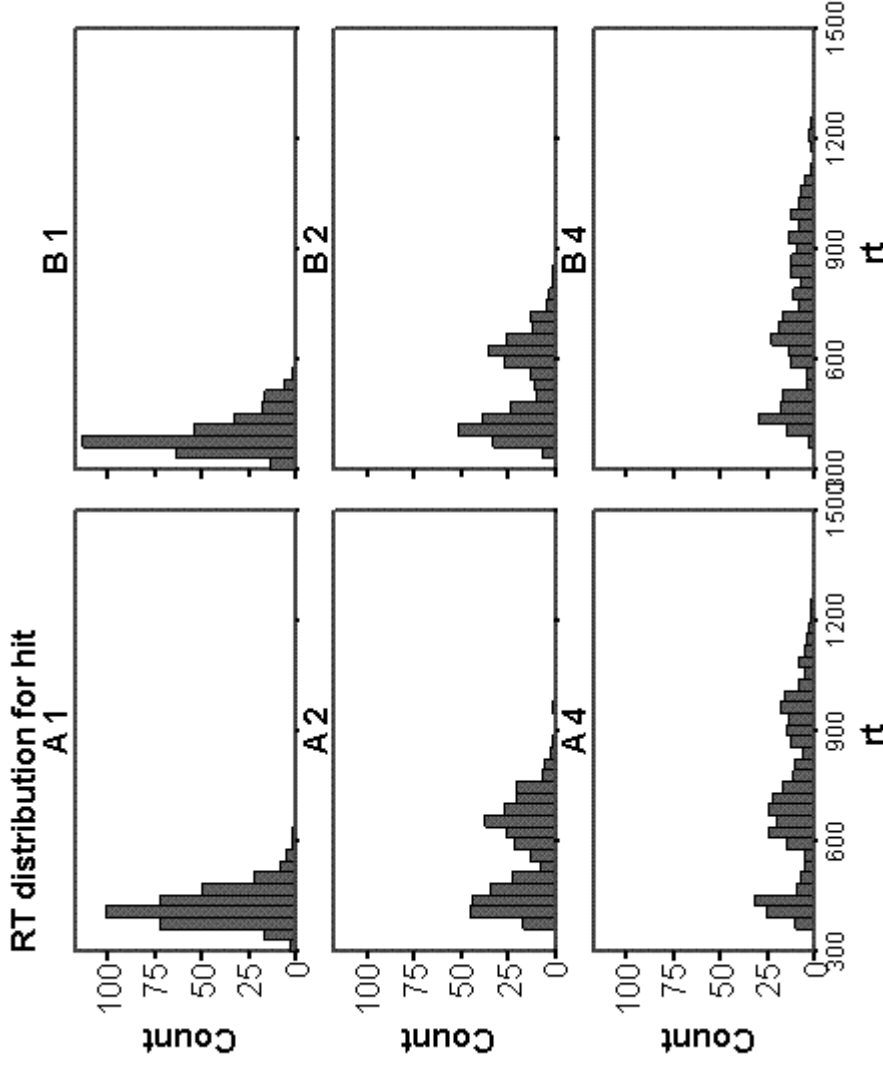


⇐ **Both serial and self-terminating**

⇐ **Parallel or exhaustive**

* **In one experiment, both patterns***

A- Searching mode



The presence of multimodal distributions of RT implies

- Seriality and
 - Self-Termination
- on positive trials (SST \oplus).**

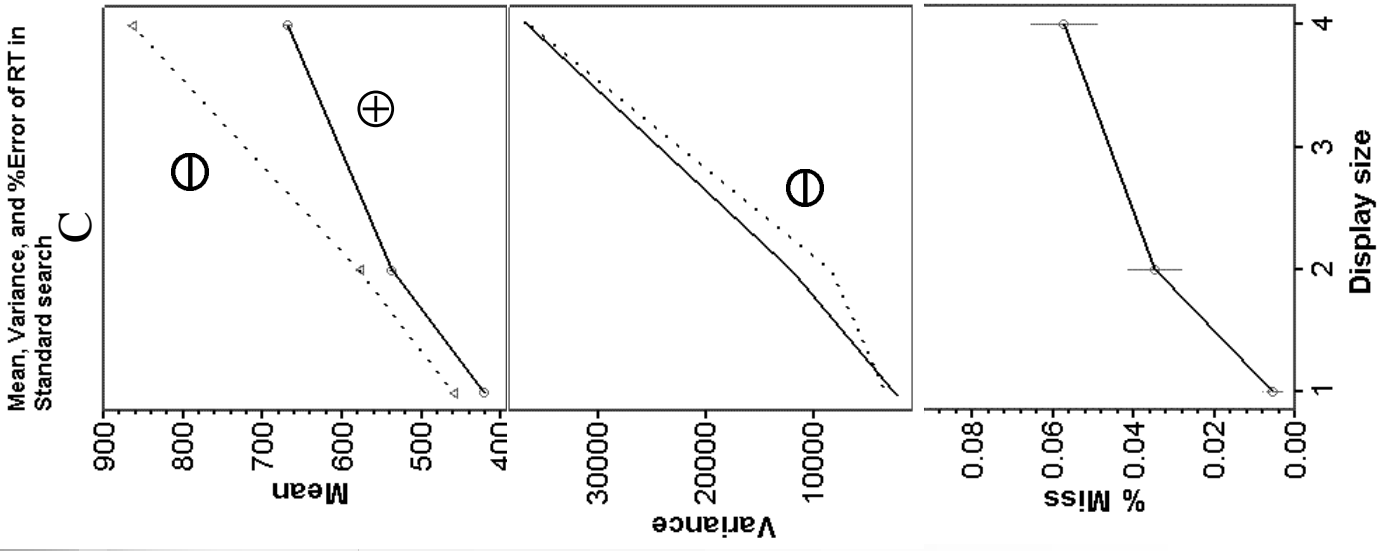
(for parallel processing with a fixed capacity of 1)

Both subjects have the same pattern.

But would imply a 2:1 ratio...

Visible in part because the stimuli are very difficult to distinguish and therefore the subjects are slow...

B1 - Stopping rule | SST ⊕



Response type
 —○— Target present
△..... Target absent

The variance for ⊖ responses are

- more than linear with display size (against a pure exhaustive search)

The increasing Miss rate suggests:

- an equivalent Correct Guess (CG) rate
- the longer the trial lasts the more CG are likely.

Suggest a Quasi-Exhaustive (QE) search for negative trials.

B1- Stopping rule | SST⁺: Quasi-Exhaustive search on Θ

- **Assumption: probability $1-p$ that subject finishes his search too soon (p estimated from Miss rate)**
- **Therefore: The actual number of comparison (d') is slightly smaller than the actual display size (d)**

$$MN^-(d) = d \cdot E(T) + E(I)$$

$$VAR^-(d) = d \cdot VAR(T) + Var(d') \cdot E^2(T)$$

- **This “correction” can be solved and used to remove the impact of CG on the data:**

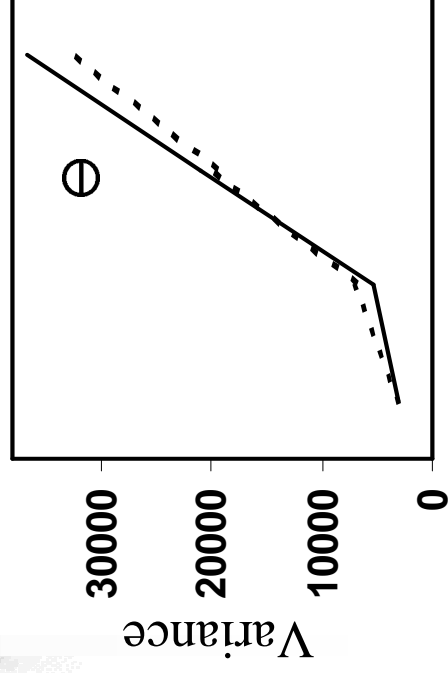
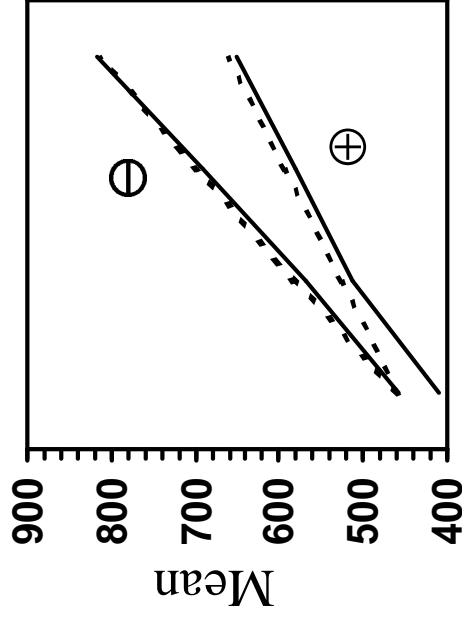
B1- Stopping rule | QES \ominus

In a QES, Negative variance is also increasing quadratically.

The fit is not too bad; captures the trend of the variance on \ominus and \oplus trials.

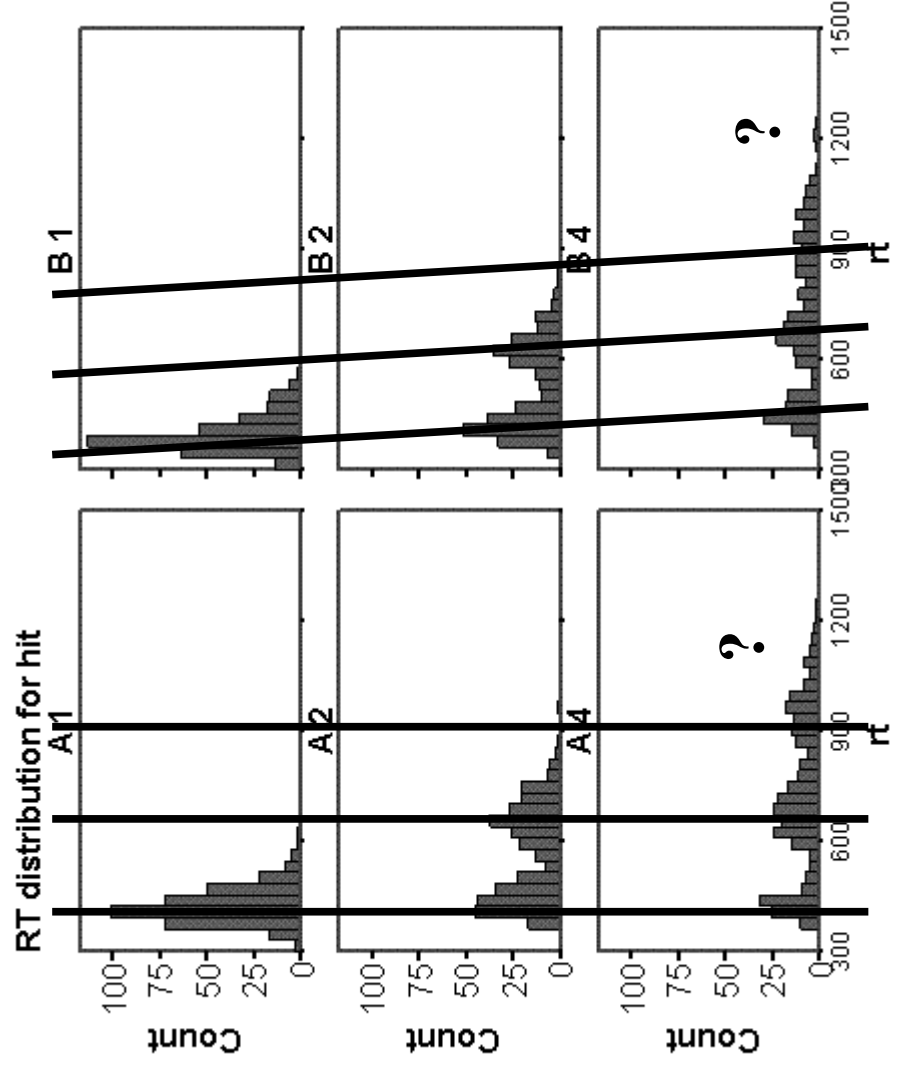
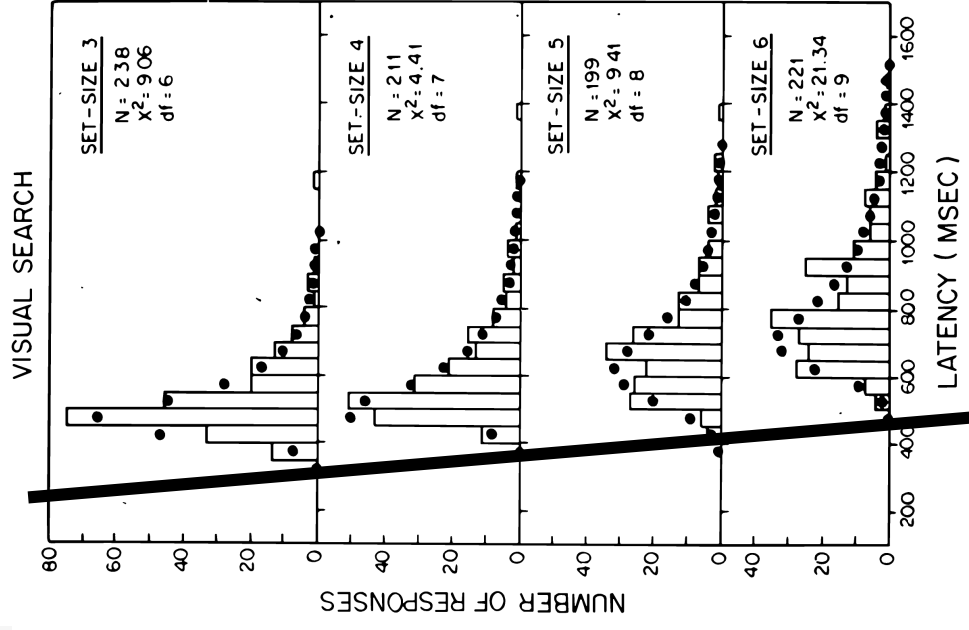
Such “corrections” could lead to a slope ratio of 1.8 : 1, because the effect is larger for large display;

However, it overestimate the \oplus mean RT on display size of 1.



— Observed
- - - Predicted

B2- Starting phase

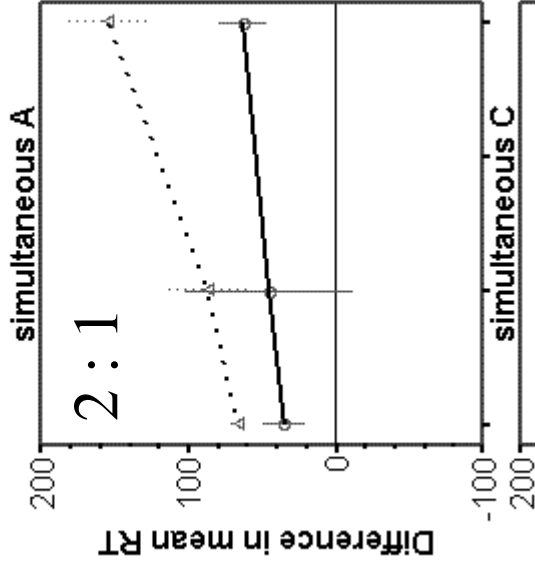


**Subject B is taking “a big breath” before starting to search...
This delay before starting a search task was observed by Hockley (1984).
What is going on? Related to a “preparation stage”
Tested by removing possibility of being prepared, and by the FIFO effect.**

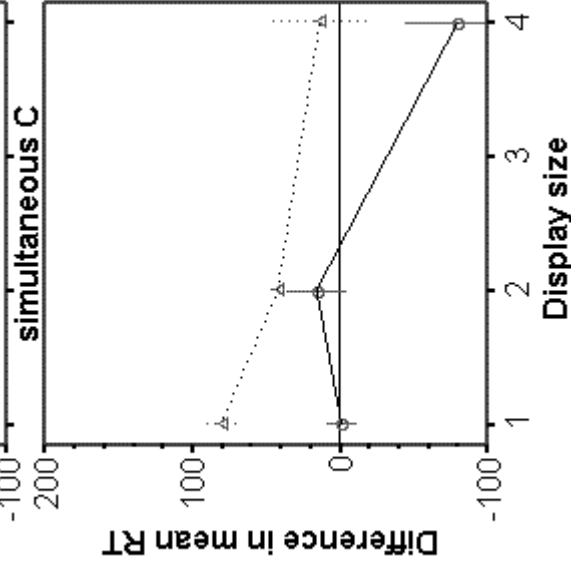
B2- Starting phase:

Removing preparation stage

Difference between Mean RT witho:
preparation and standard mean RT



⇐ **The possible absence of preparation slows subject A (over-additive effect); Slope ratio in slow-down is 2 : 1, suggesting a self-terminating stage embedded in the scanning slope.**

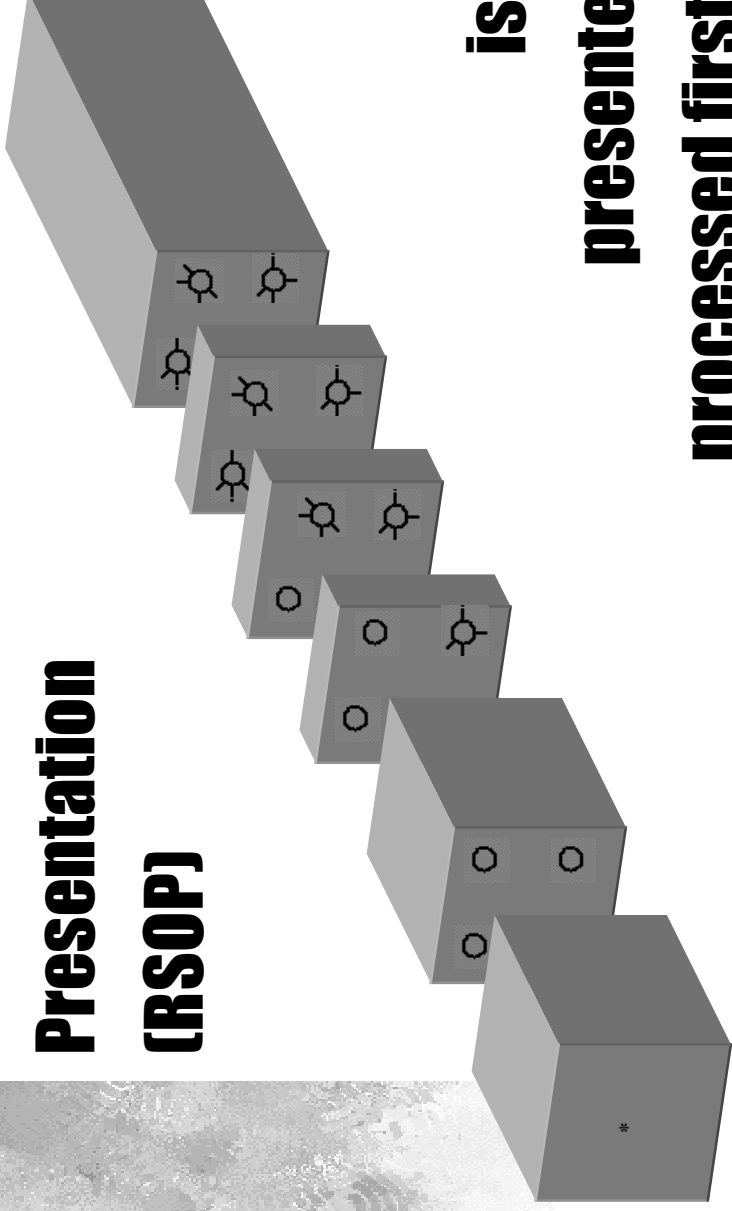


⇐ **Absence-of-preparation effect washes out with display size (under-additive effect); Slope of the effect is 1 : 1, suggesting an exhaustive stage of preparation, maybe in parallel.**

B2- Starting phase: a lack of FIFO effect

**Rapid Serial Object
Presentation
(RSOP)**

ISI are 16, 33 and 50 ms

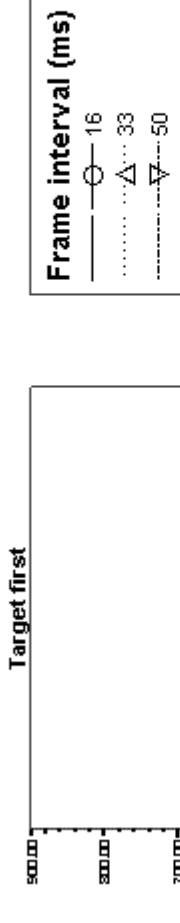


**The main idea
is that if the target is
presented first, it should be
processed first (in a serial model)**

⇒ **Prediction: no slope effect when target presented
first (First In, First Out effect).**

B2- Starting phase: a lack of FIFO effect

Mean reaction time in the RSSP without circles before the trial starts



When the target is first, RT for d4 are never smaller than RT for d2, suggesting that the preparation time lasts at least two frames (slowest ISI is 50 ms per frame) = 100 ms.

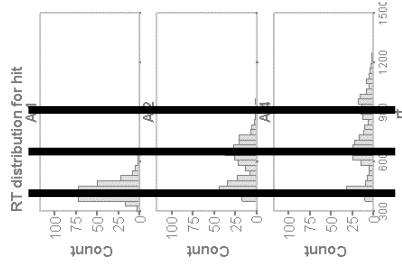
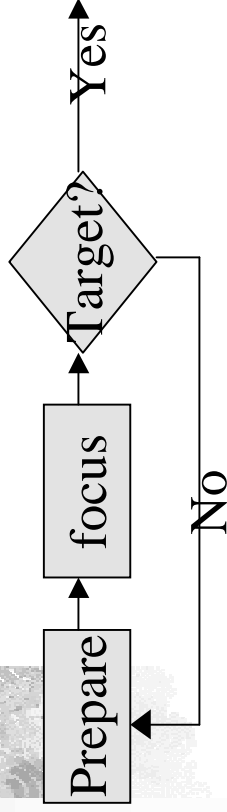
When the target is the last object to appear, RT are delayed the time to present the three following frames;

A Break

Seems essentials:

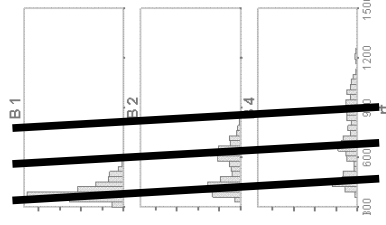
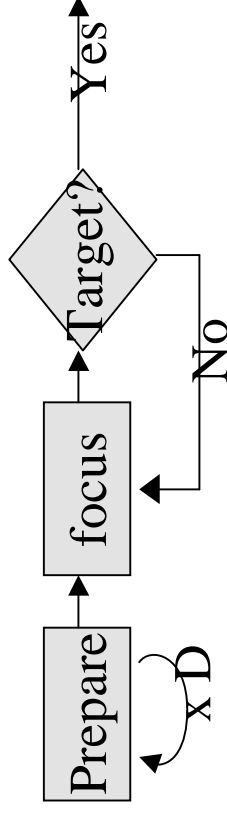
- Serial search mode
- Stopping rule for both positive (self-terminating) and negative (quasi-exhaustive) search
- Starting phase: preparation phase that depends on the number of objects

The starting phase can either be embedded i.e. self-terminating too



predicts slope ratio of 2 : 1

performed before the search begins i.e. exhaustive



predicts slope ratio ~ 1.5 : 1

C- Identification

Many models of identification:

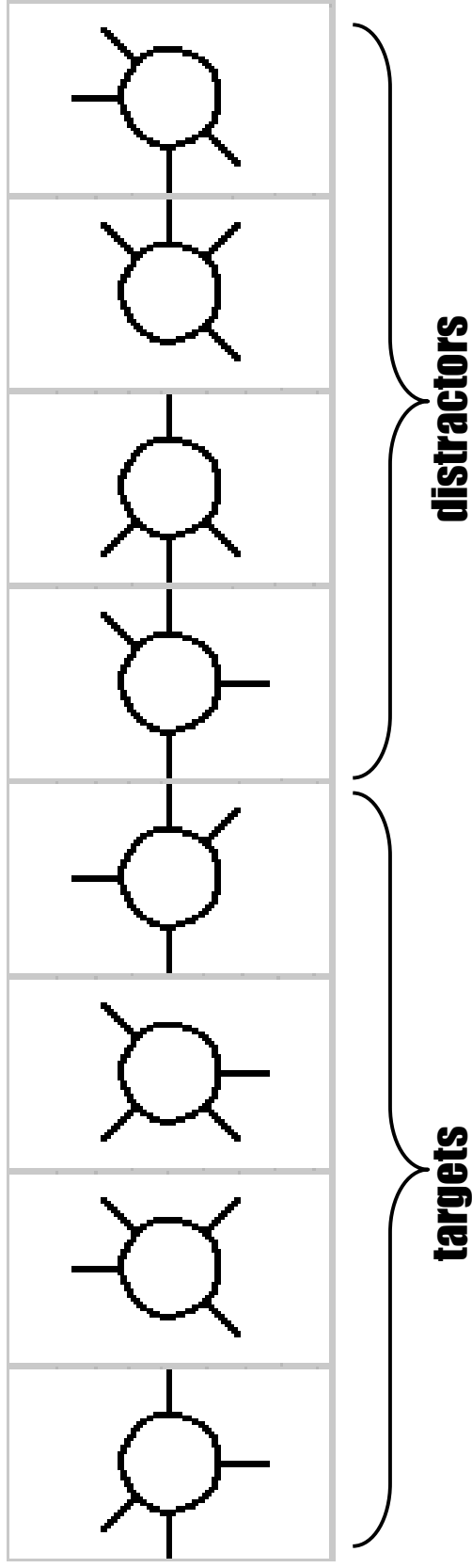
- **Holistic** **no capacity issue**
- **Reduction of info** **capacity increases w/ diagnosticity**
- **Chunking** **capacity stable with pattern size**
- **Threshold:** **?**
 - **Simple-sample (SDT)**
 - **Multiple-sample (RW)**

Chunking can either result from:

- **Unitization (early process)**
- **Binding (late process)** **with respect to bottleneck**

C- Identification:

the stimuli

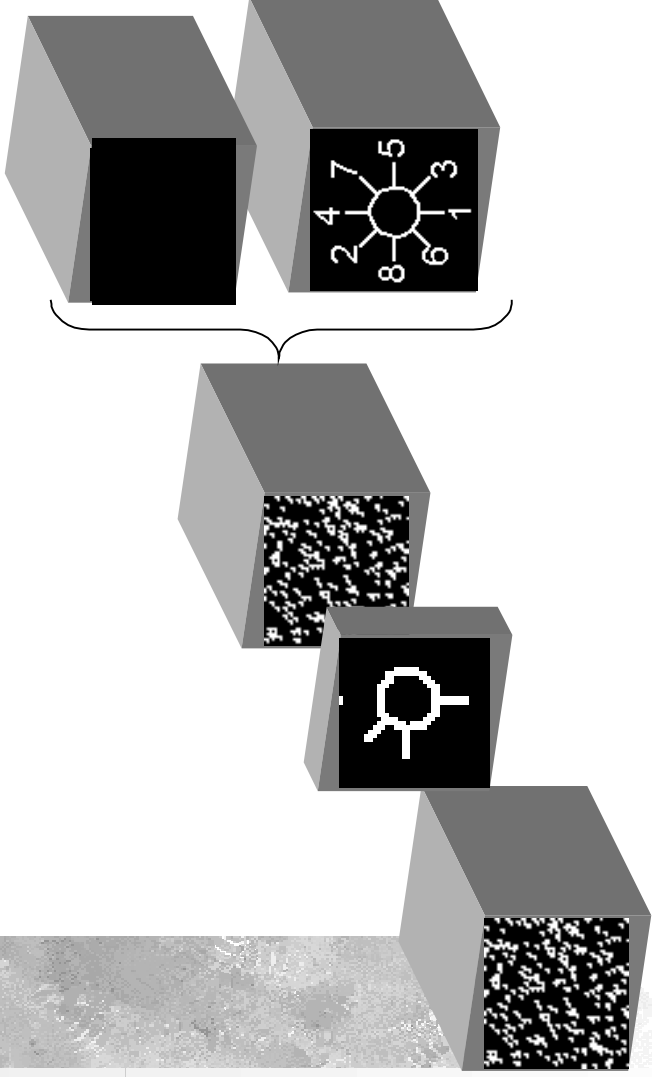


These stimuli are very difficult to learn:

- The features don't connect (no emergence)
- The similarity is controlled (within- and between-category similarity are equal)
- Diagnosticity of the features are control: a conjunction of features defines the targets.

C- Identification:

A detection-of-feature task

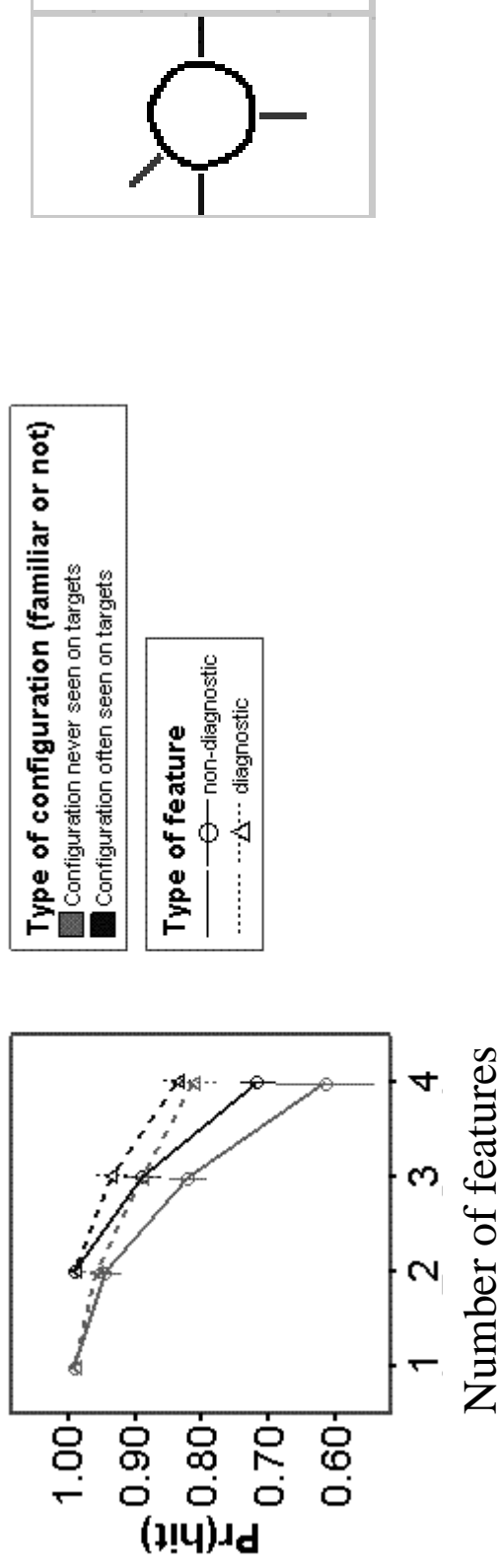


This task, introduced by Townsend et al. 1981, alternated with the search task during the 32 first sessions.

- **Two questions:**
 - **is it a target (rarely the case)?;**
 - **what were the features you saw?**

C- Identification:

Detection task results.

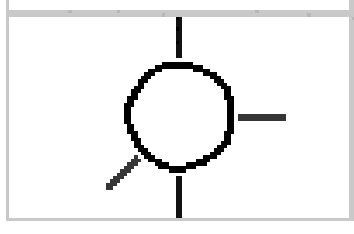


Type of configuration (familiar or not)

■ Configuration never seen on targets
■ Configuration often seen on targets

Type of feature

○ non-diagnostic
△ diagnostic



- **Limited capacity for all but subject B (related to decay?)**
- **Diagnostic features takes less space OR are prioritized before decay (with a multiplicative effect)**
⇒ **Perceptual gain ?**
- **Known configurations are recalled more effectively (with an additive effect) ⇒ Mutual facilitation**

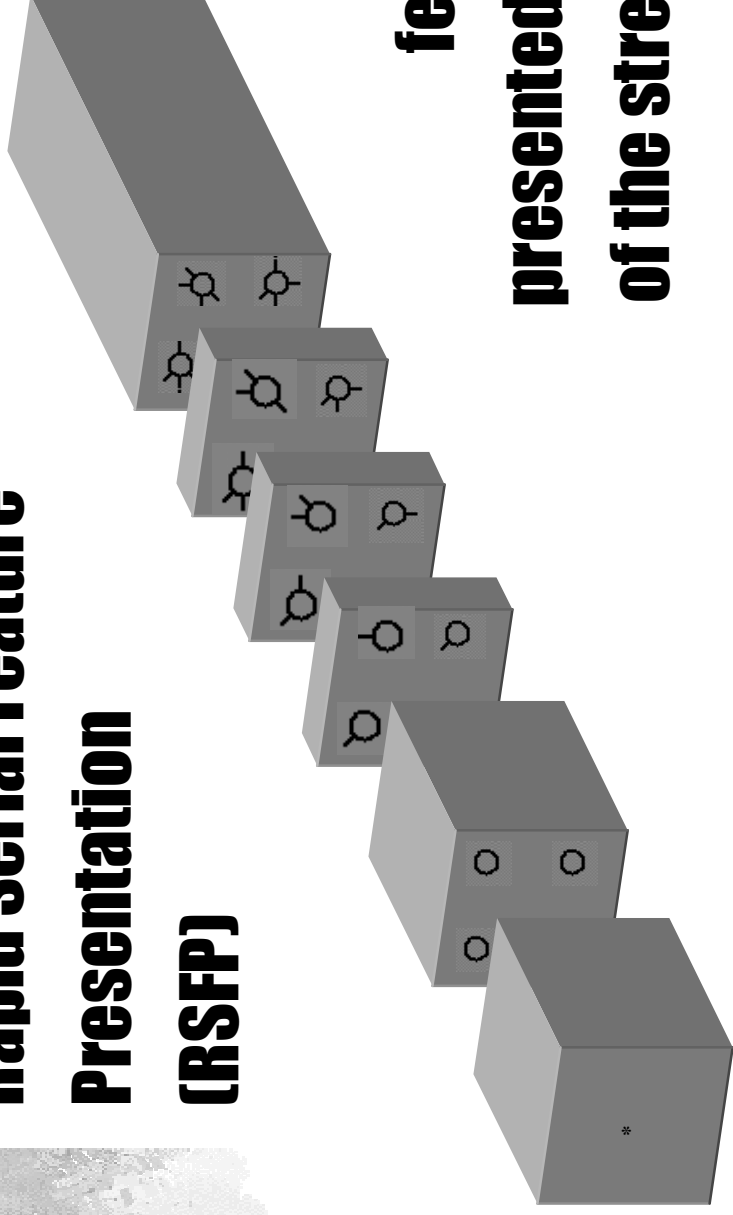
C- Identification:

Feature presentation task

Is diagnosticity used as well in speeded-reaction time experiment?

Rapid Serial Feature Presentation (RSFP)

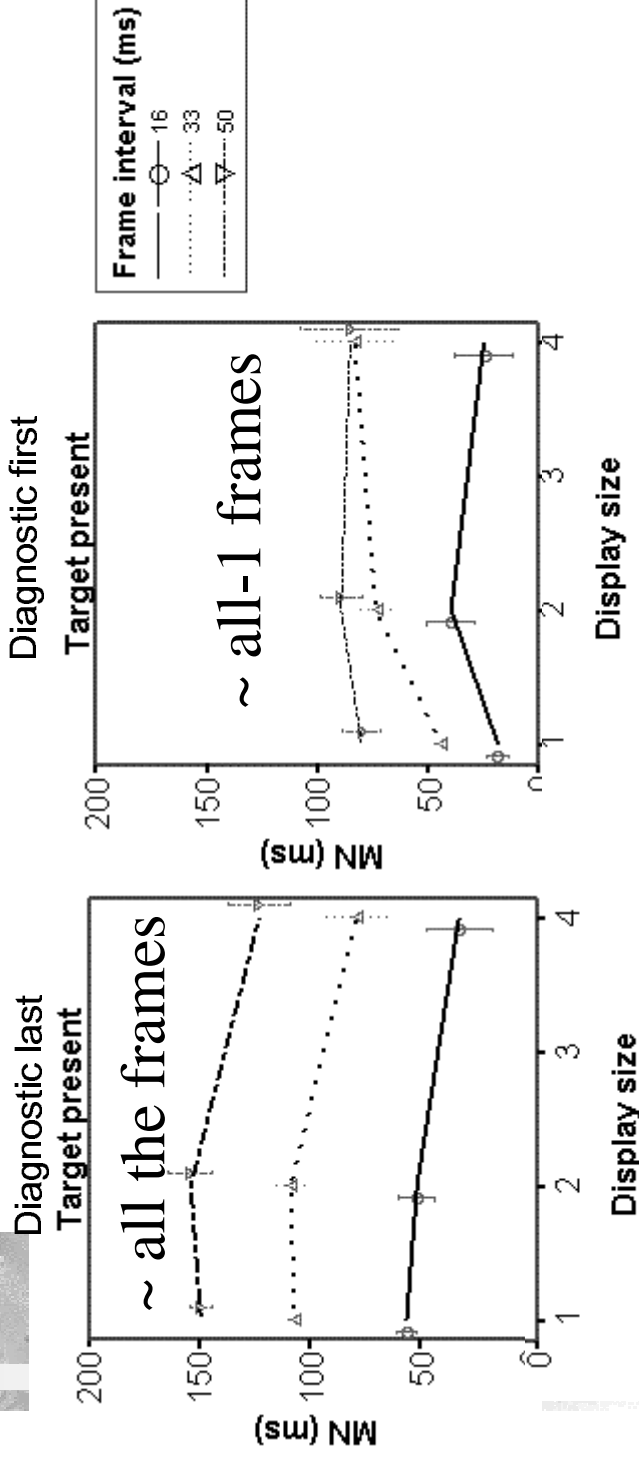
ISI are 16, 33 and 50 ms



The diagnostic features are either presented at the beginning of the stream, or at the end.

C- Identification:

Feature presentation results



If diagnostic conjunction delayed to the end of the sequence: Subjects wait for the whole object to appear

If diagnostic conjunction showed first: subjects can ignore the last frame.

⇒ **small processing gain for diagnostic information first, because irrelevant information partly ignored**

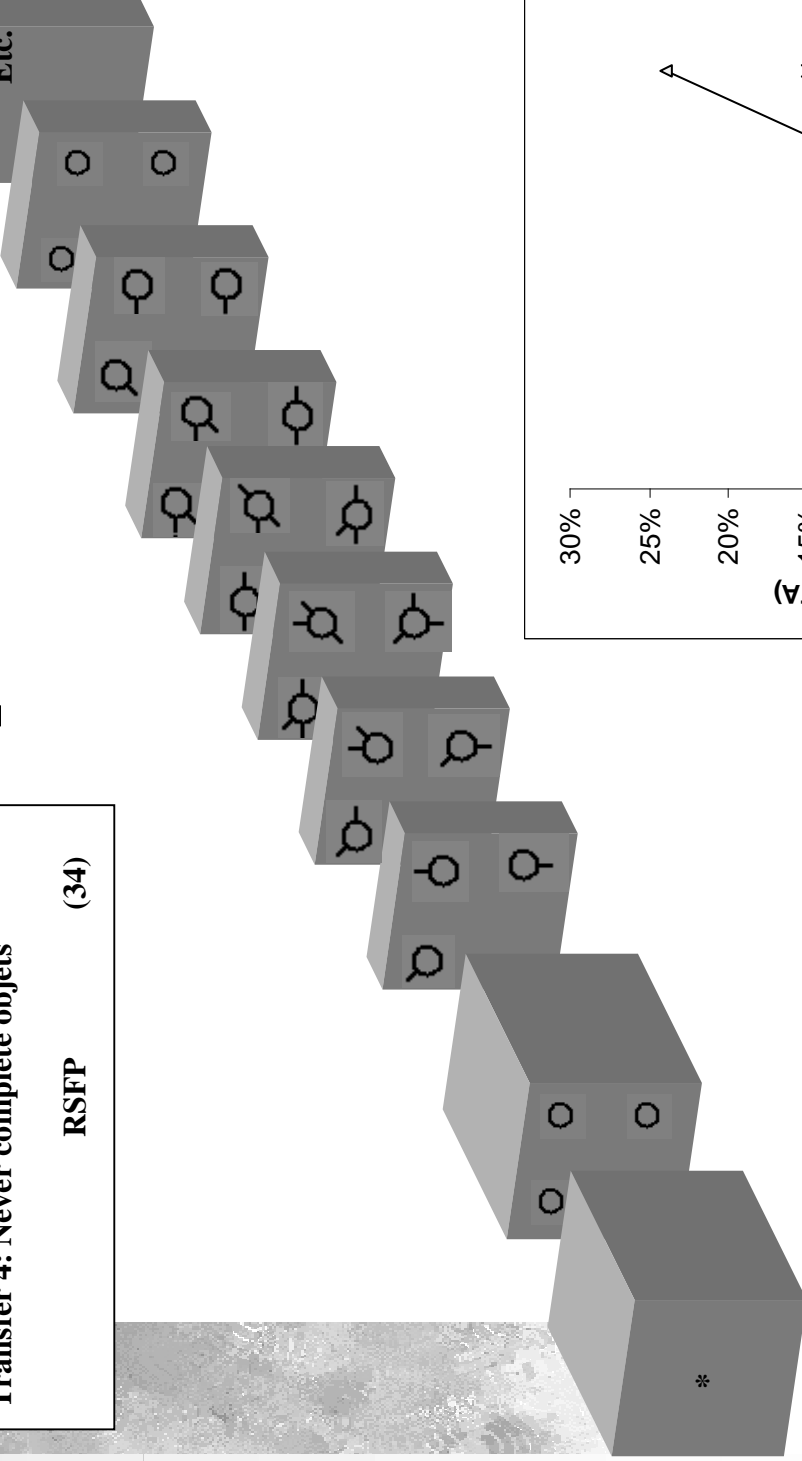
C- Identification:

Incomplete presentation results

Transfer 4: Never complete objects

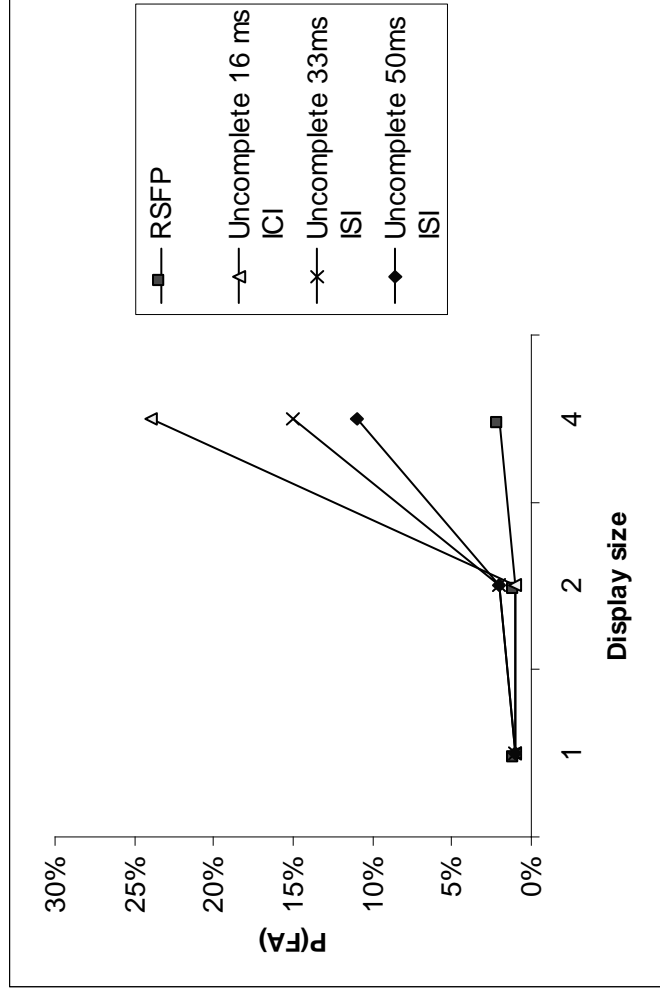
RSFP (34)

Etc.



FA increases enormously!

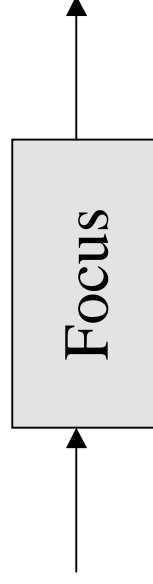
In favor of a late processing: binding?



A Brief Conclusion

C: Identification:

- perceptual learning (or very early priority) for diagnostic information;
- late “memory effect” for mutual facilitation of conjunction.



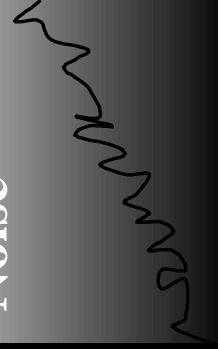
Time to focus depends on capacity

Capacity depends on learned diagnosticity

Binding is supported by mutual facilitation



Noise



Available at:

<http://Prelude.Psy.UMontreal.CA/~cousined/talks>