

Self terminating, guided or accumulator models of visual search: Evidence from stimulus inversion

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Inefficient search Happy?

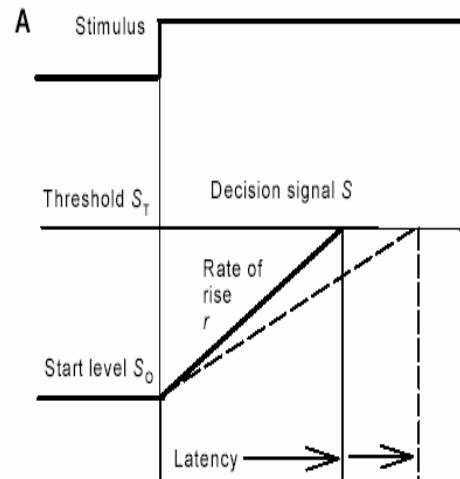


Efficient search Blonde?



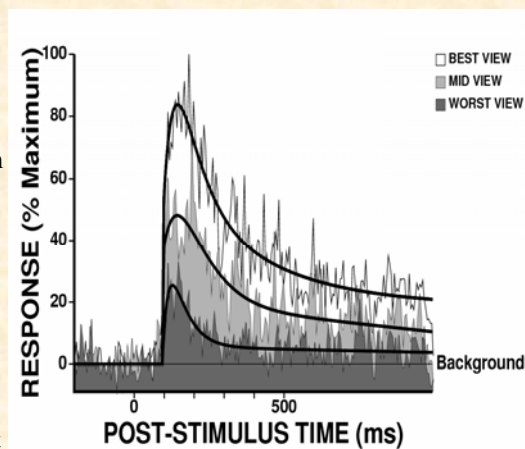
Accumulator models & visual search

- Information acquisition hypothesis
 - E.g. Ratcliff 1978; McClelland 1979; Loftus 1983; Carpenter & Williams, 1995; Gold & Shadlen, 2001

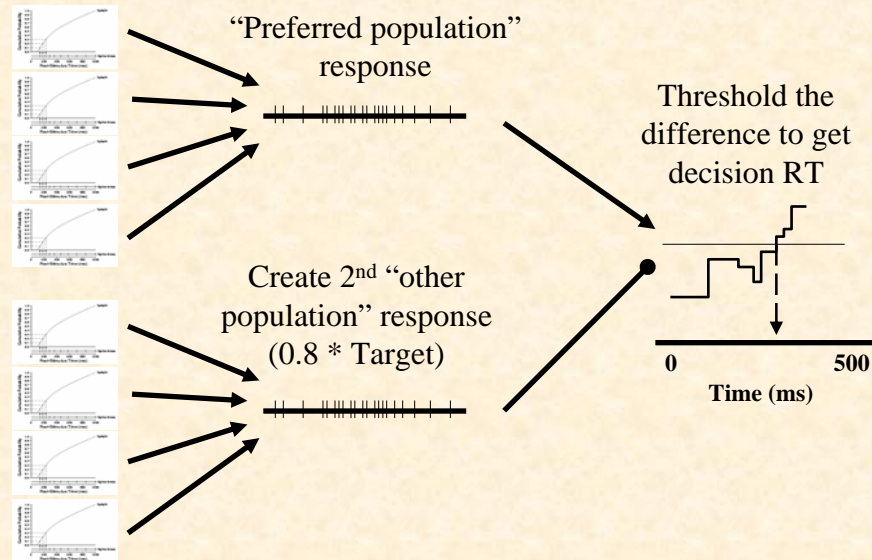


Accumulator models & visual search

- Data from macaque temporal lobe
 - Individual cell response profile (Oram & Perrett 1992)
 - Use numbers of neurones with “preferred” orientations to generate population responses (Wachsmuth et al 1994)



Modeling an item “decision”



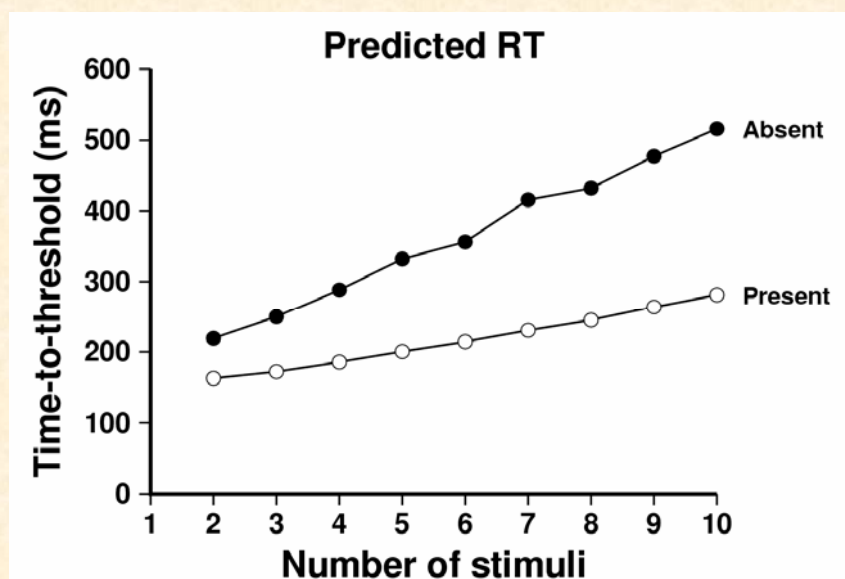
Accumulator models & visual search

- For each stimulus:
 - Preferred Population = maximally excited by stimulus
 - Other Population = $0.8 * \text{Preferred Population}$
 - Target population has “attention” gain (e.g. Desimone & Duncan 1995; McAdams & Maunsell 1999; Reynolds & Desimone 2001)
- Model inhibitory interactions between stimulus representations:
 - Scale all responses by $1/\sqrt{N}$ (Ward & McClelland 1989)

Accumulator models & visual search

- Compare “preferred population” responses with “other population” responses in **parallel**
 - Of interest is each “target population” versus “non-target population” comparison

Accumulator models & visual search



Visual search: Accumulator model

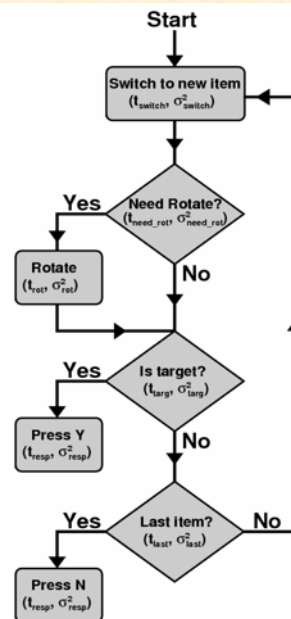
- **RT related to difference in activity (“preferred” vs “distracter”)**
 - Attention “gain”:
 - Target present difference > target absent
 - As set size increases:
 - Difference decreases
 - Inversion scales responses
 - Upright difference > Inverted difference
 - **Effect of inversion on RT**
 - **Upright < Inverted**
 - **Scales with set size**
 - **Greater for target absent than target present**

Accumulator model: Mixed inversion

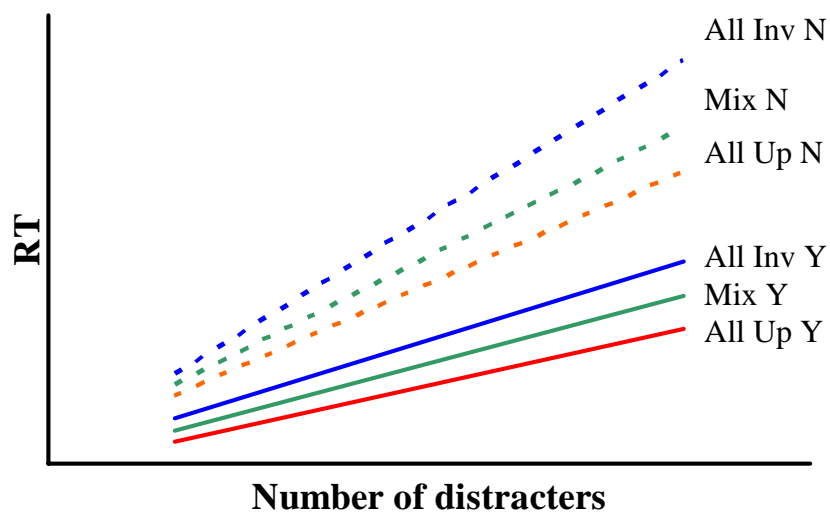
- **RT(Y) determined by orientation of target**
 - **Target upright:** Target upright vs distracter upright
 - **Target inverted:** Target inverted vs distracter inverted
 - **All upright=Mix upright < All inverted=mix inverted**
- **RT(N) determined by presence of inverted item**
 - With half upright half inverted:
 - Some non-target inverted vs distracter inverted (same as all inverted)
 - **All upright < mix inversion=All inverted**

STSS and mixed Inversion

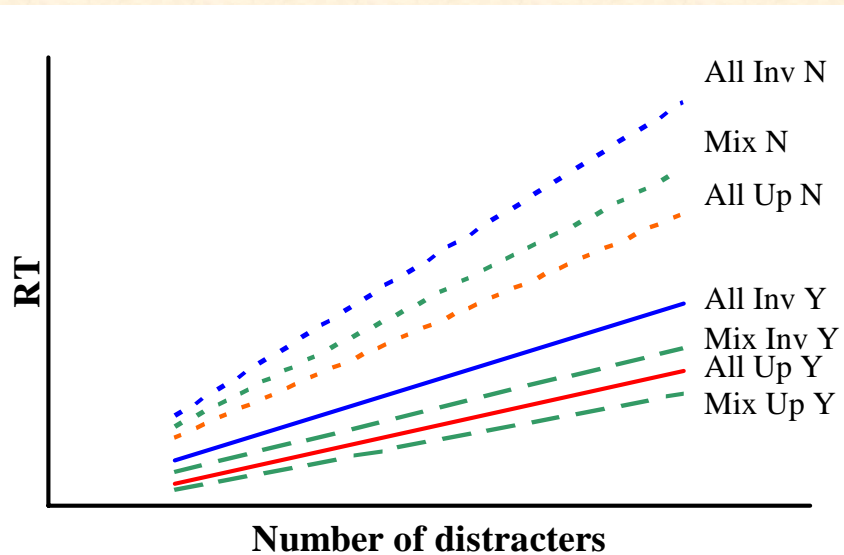
- **STSS** (Treisman & Gelade 1980)
 - RT(Y) ½ items need rotating
 - RT(N) ½ items need rotating
- **Guided search** (Wolfe et al. 1989)
 - Upright “more likely” than inverted?
 - $RT(Y_{mix_up}) < RT(Y_{up})$
 - $RT(Y_{mix_inv}) > RT(Y_{up})$
 - Otherwise same pattern as STSS
 - But faster RT



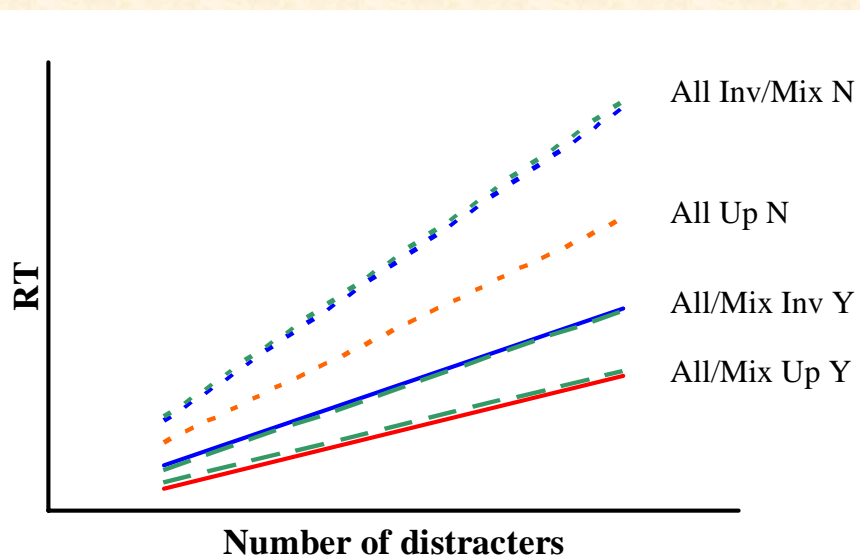
STSS Predictions



Guided search predictions



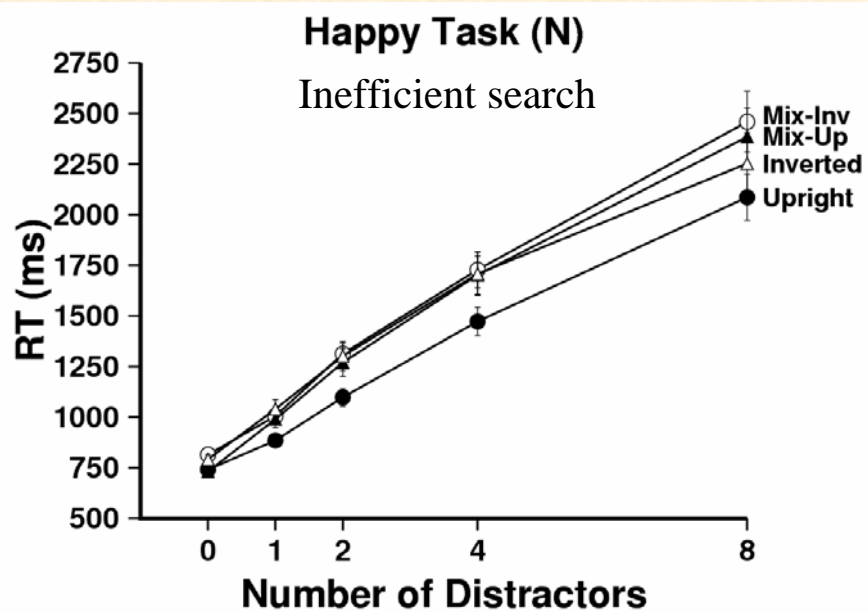
Accumulator model predictions



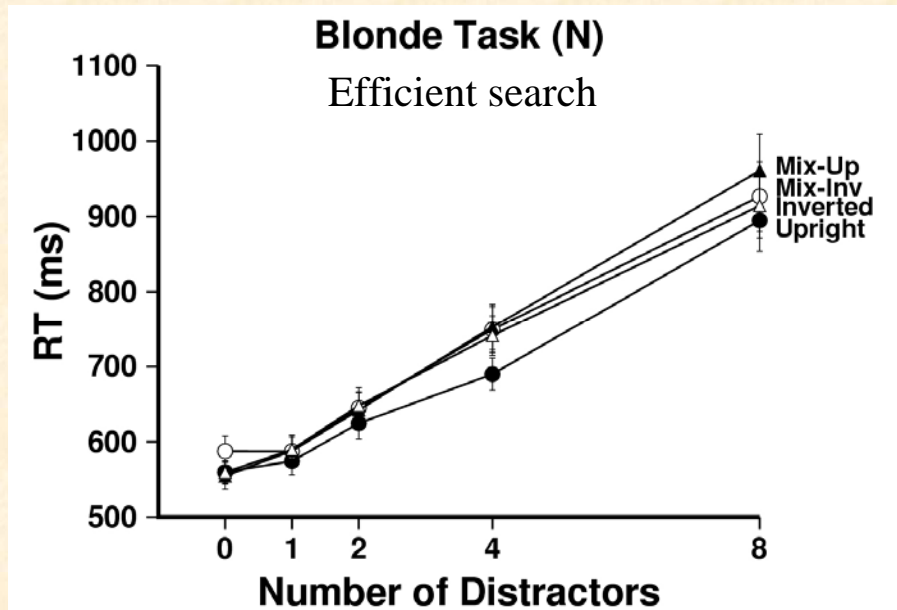
Visual search with mixed inversion



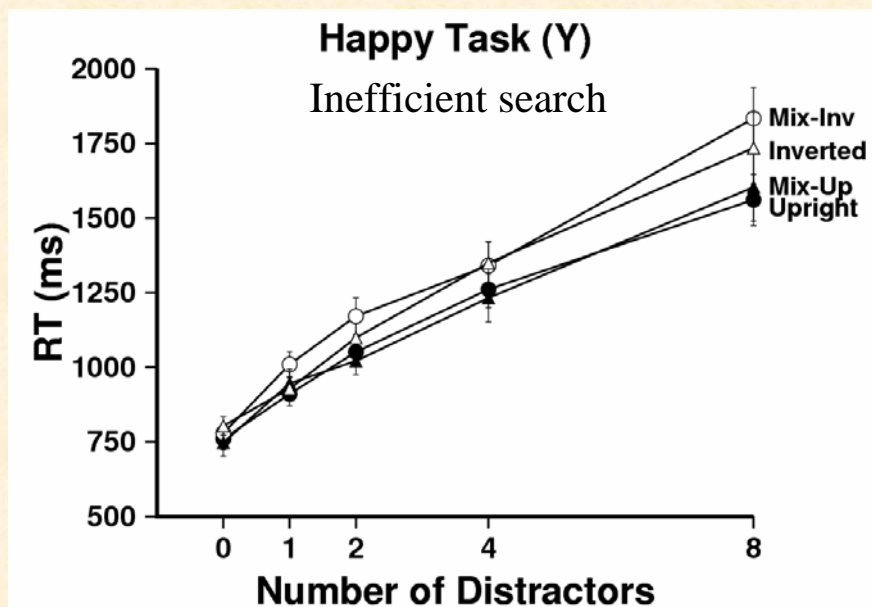
Visual search: Mixed orientation (N=27)



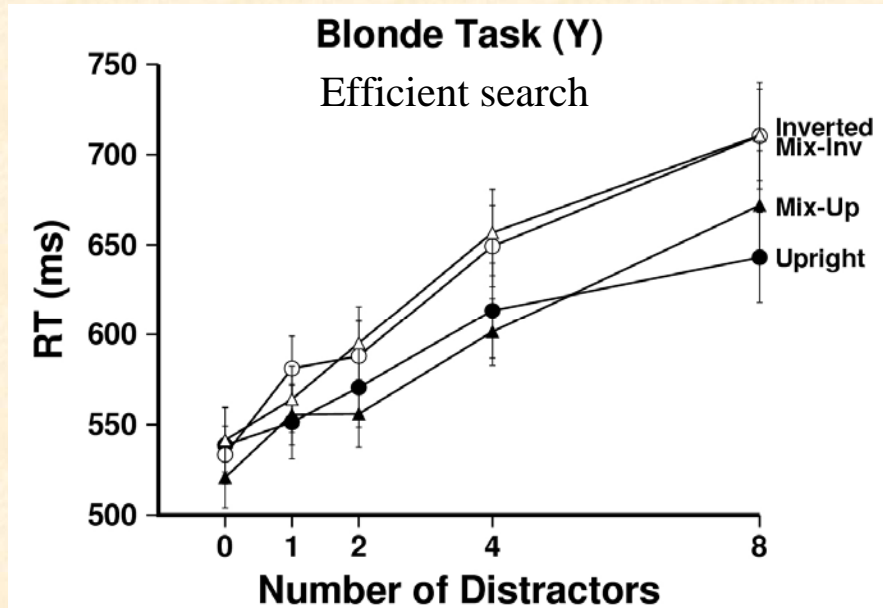
Visual search: Mixed orientation (N=27)



Visual search: Mixed orientation (N=27)



Visual search: Mixed orientation (N=27)



Summary of results

- **Target present - RT(Y)**
 - determined by orientation of target
 - Mixed-upright target = all upright
 - Mixed-inverted target = all inverted
- **Target absent - RT(N)**
 - determined by an inverted item
 - Mixed = all inverted > all upright

Conclusions

- **Can use “mixed” conditions to distinguish between models**
- **Data support accumulator model**
 - over self-terminating & guided search models
 - also standard signal detection theory models (Palmer et al 2000; Vergheze 2004)

Visual Search and VSTM

VSTM in visual search:

- Maybe not involved (Woodman et al. 2001)
- Executive processes (Han & Kim 2004)

OR Inhibitory interactions in visual system?

- Giving rise to attention gain: $RT(Y) < RT(N)$
- Increasing RT with increasing set size
- Executive processes “do the accumulation”
- Same model also can account for
 - Mental rotation, size normalisation (Perrett et al. 1998)
 - Dual task performance (Oram et al 2002; Oram under revision)