ATTENTIONAL NETWORKS TEST

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Attention

Attention is represented as an activity of a set of neural networks in the brain

Types:

- *Exogenous* - shift automatically
- *Endogenous* - directed voluntary
- *Overt* - includes eye-movement
- *Covert*

Three types based on three main functions (Posner, Peterson, 1990):

- maintaining the general state of *alertness*
- *orienting* to spatial stimuli
- choosing what stimuli require conscious processing and what stimuli do not, i.e., the function of *executive control*

Alerting function

= the ability to prepare and sustain alertness to process high priority signals

- Tonic - right hemisphere, thalamic areas
- Phasic - left hemisphere
- NA system

- higher Alertness – smaller RT – higher error rate (ER)

Task - using an abstract signal in the beginning of the trial before the target is drawn on the screen (Posner cueing task)

Alerting function

Orienting function

= ability to detect where a stimulus is localized

- Dorsal and Ventral pathways

- Overtly (saccade planning)
- Covertly (mental; looking vs. seeing)
- Endogenous
- Exogenous

Task – spatial arrow detection task (Posner, Nissen, Ogden, 1978)

Executive control function

= aims to resolve a conflict between stimuli

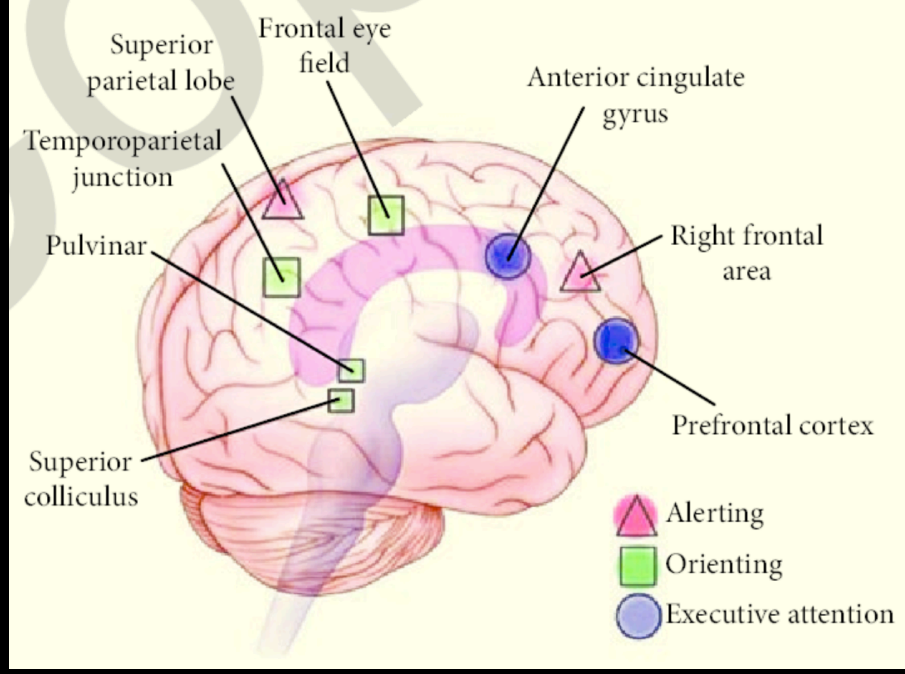
- Fronto-parietal network
  - organizes behavior (task switching required)
  - operates more in real time, adjusting reactions accordingly to demands at a given moment

- Anterior cingulate cortex
  - background maintenance for stable performance across all trials no matter their specifics (Dosenbach et al., 2008)
  - Conflict detection

Task - The Flanker Test

Table 1 A summary of the anatomy and chemical modulators involved in the alerting, orienting, and executive attention networks.

Function	Structures	Modulator
Orient	Superior parietal Temporal parietal junction Frontal eye fields Superior colliculus	Acetylcholine
Alert	Locus coeruleus Right frontal Parietal cortex	Norepinephrine
Executive attention	Anterior cingulate Lateral ventral Prefrontal Basal ganglia	Dopamine



Posner et al., 2007

To study Attention

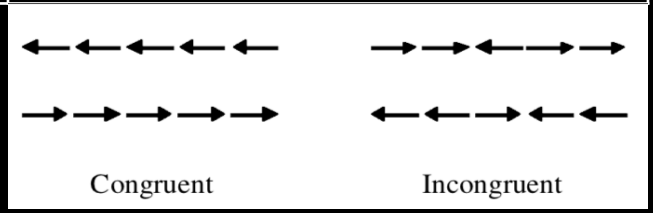
- Behavioral measurements:
  - RT
  - Accuracy

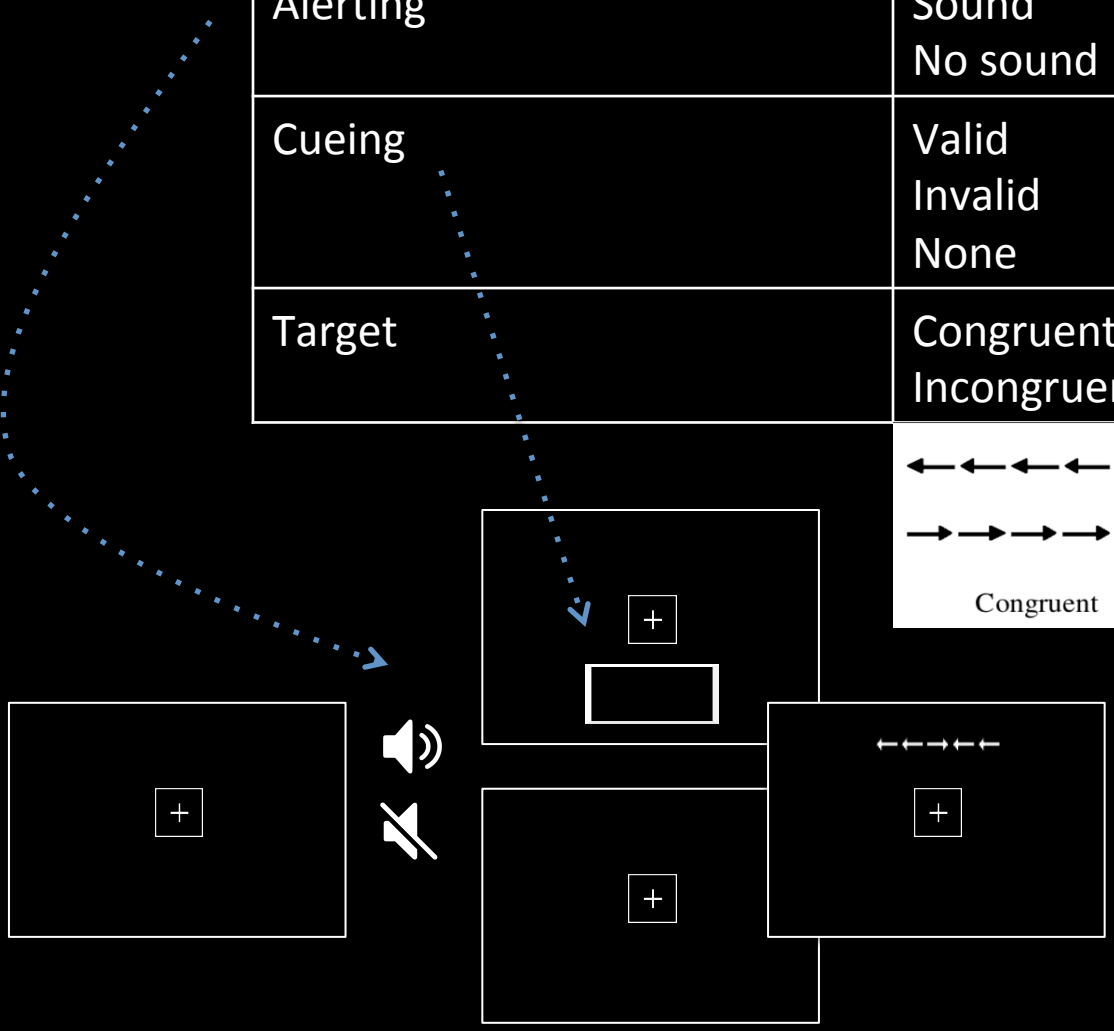
- Attentional Networks Test (ANT)
  - allows studying attention as a system of three networks (Fan et al., 2002)
  - could be used to obtain a measure of the efficiency of each of the networks
  - is simple enough to obtain data from children, patients, and animals

- Manual response - ANT-M
- Saccadic response - ANT-S

ANT-M: Design

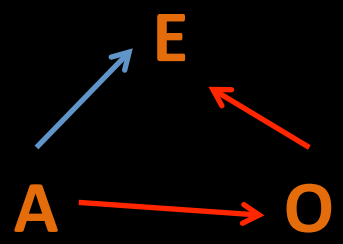
Alerting	Sound No sound
Cueing	Valid Invalid None
Target	Congruent Incongruent

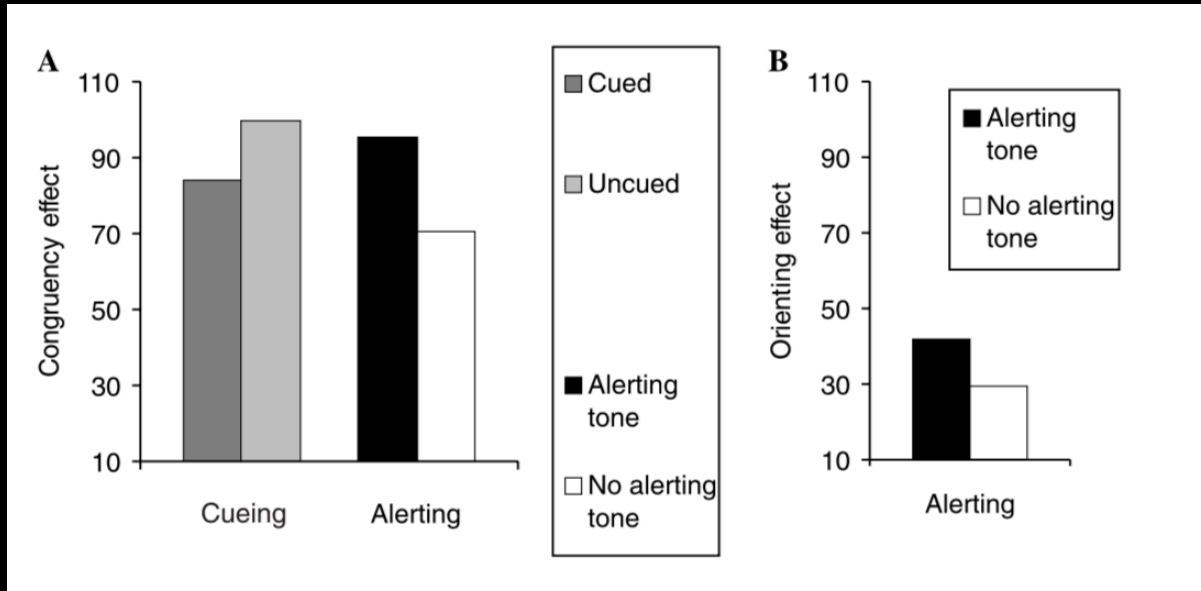




ANT-M: Results

- Alerting ~ Executive
  - A shutdown E (fast RT, low engagement in higher level processing, Posner (1994))
  - A inhibits E (Callejas et al, 2004)
- Alerting ~ Orienting
  - independent (Fernandez-Duque and Posner, 1997)
  - A increased O (Callejas et al, 2004)
- Orienting ~ Executive
  - E larger for participants oriented *opposite* to the target location (Funes & Lupianez, 2003)
  - O enhances E (Callejas et al, 2004)





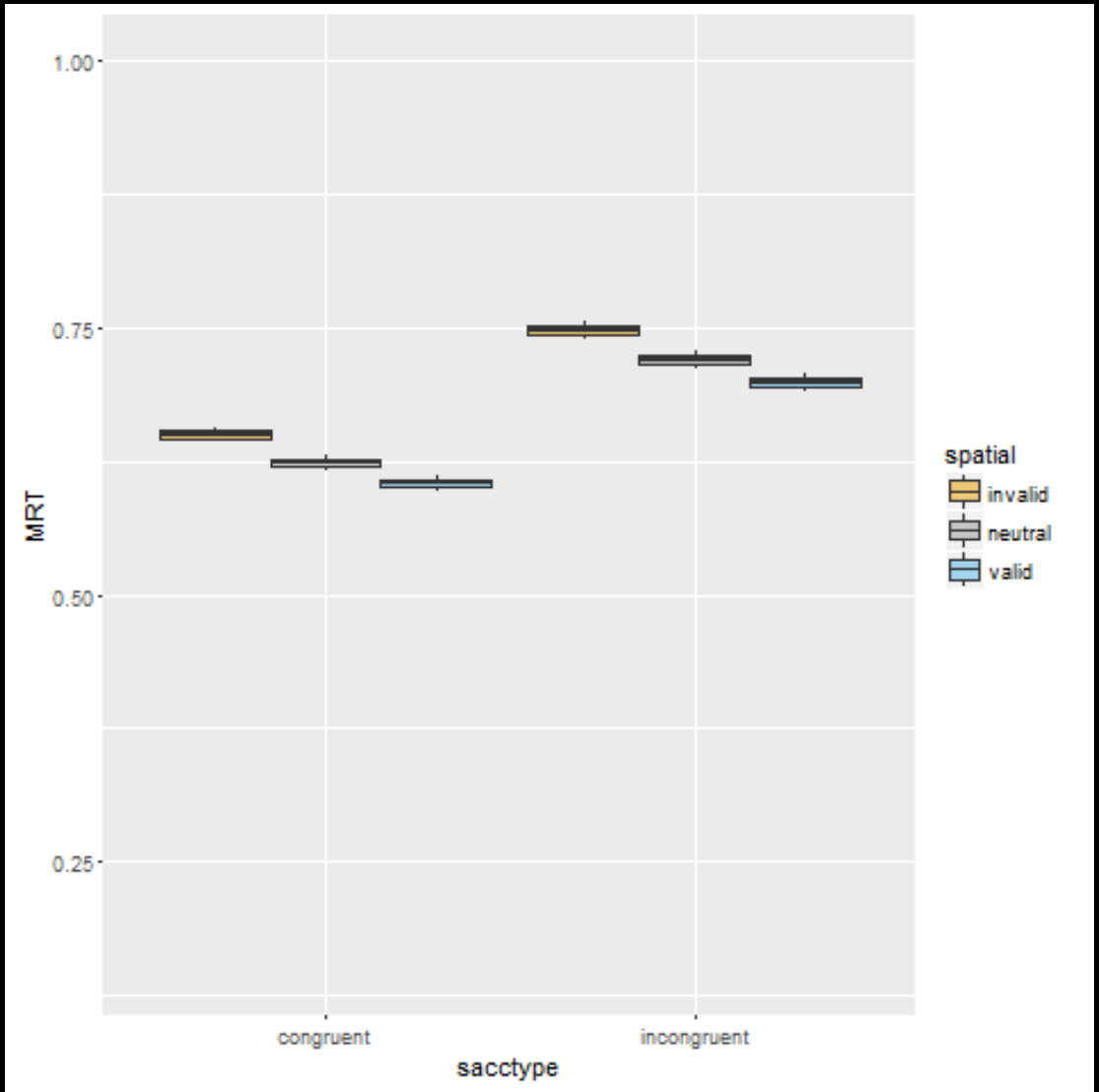
ANT-M: Results

Table 1
Mean RT in ms (percentage of errors) for each condition

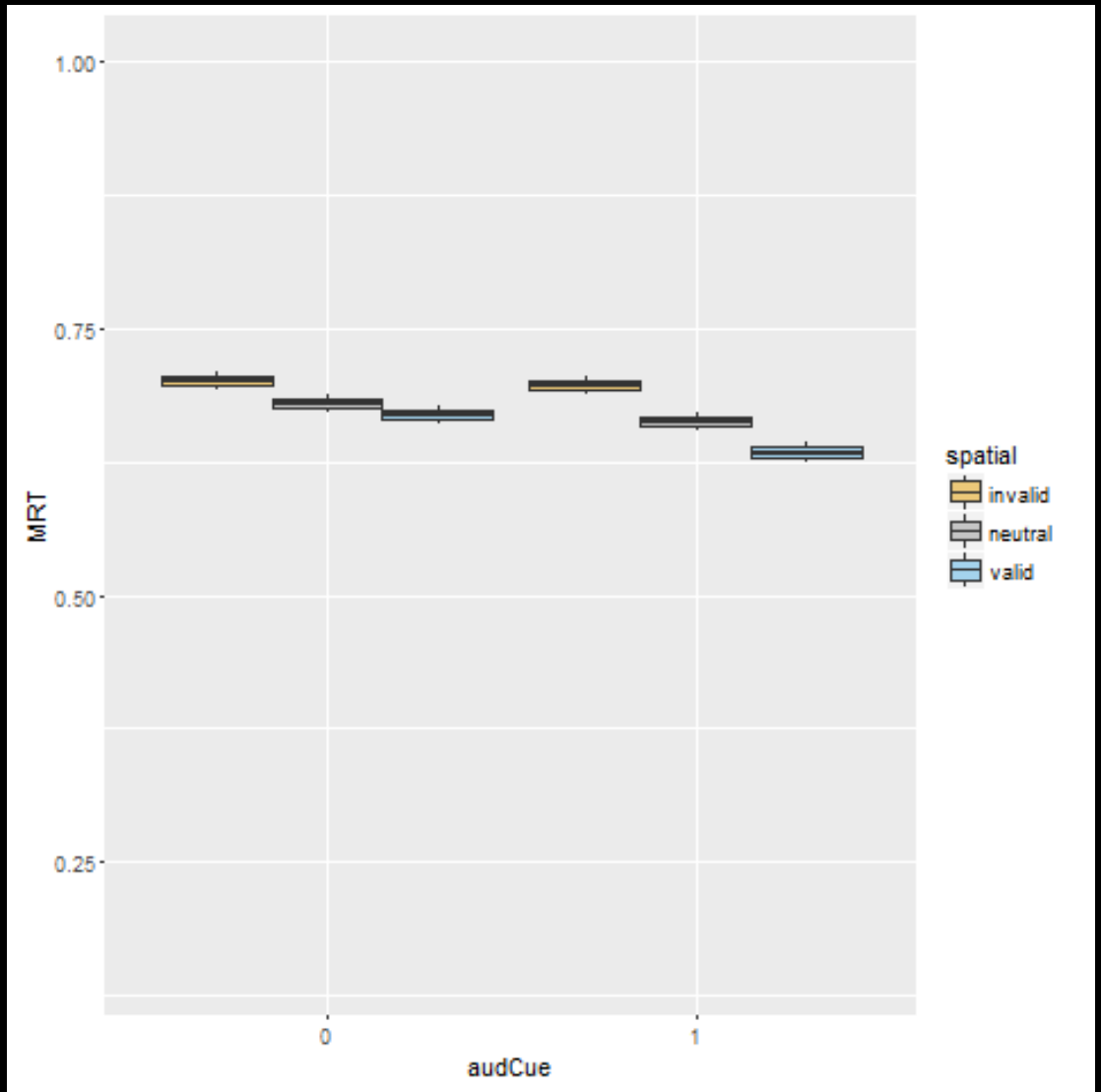
	No alerting tone		
	No cue	Cued	Uncued
Congruent	573.5 (1.39%)	533.6 (1.22%)	561.1 (1.56%)
Incongruent	644.1 (2.60%)	617.3 (3.82%)	648.9 (6.08%)

	Alerting tone		
	No cue	Cued	Uncued
Congruent	530.1 (1.74%)	519.6 (1.04%)	547.6 (1.56%)
Incongruent	625.3 (7.64%)	603.6 (3.82%)	659.3 (7.47%)

ANT-M: Results (our replication)



ANT-M: Results (our replication)



ANT-S: Methods

- ANT-S task (saccadic response)
- Eye-Link 1000 Plus
- Computational modeling (Drift-difusion model)

- Data analysis:
  - Kepler + R
  - Linear mixed effects model
  - ?ANOVA (for true lovers)

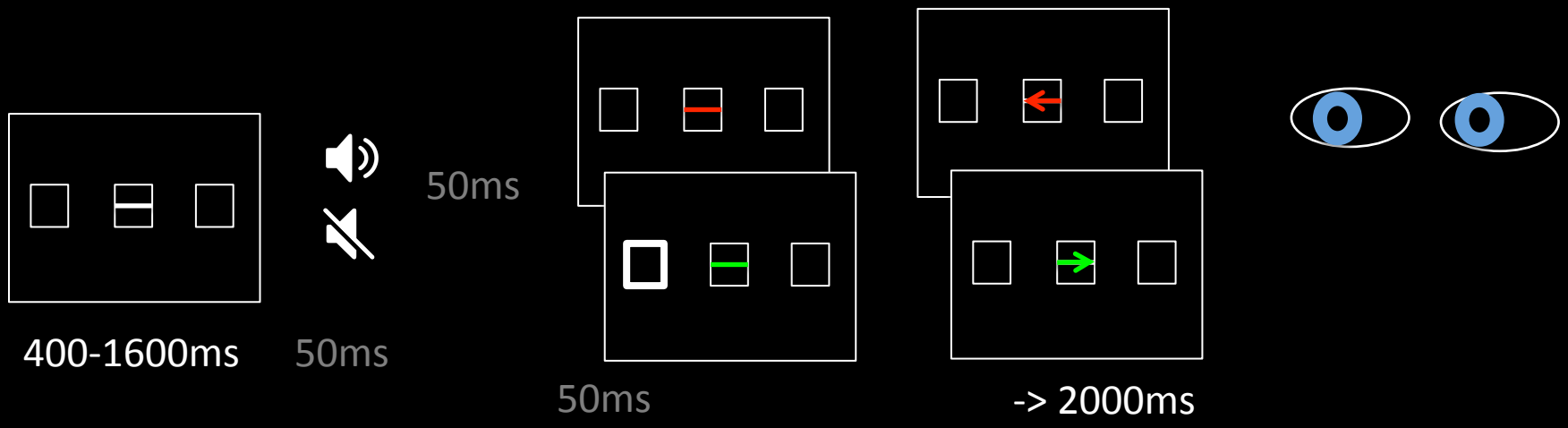
ANT-S: Hypotheses

- Executive control network of attention can be tested with the ANT in oculomotor modality (ANT-S) just as successfully as in manual response modality
  - Saccadic and antisaccadic responses are the equivalent for the congruency condition, but for oculomotor modality
  - Drift-diffusion model can be successful fit to data with both saccadic and antisaccadic responses
  - From that fit, sets of parameters that best describe the shift in the executive control network can be derived

- Executive control network of attention operates in a similar fashion regardless of what was the nature of the task in oculomotor modality

ANT-S: Procedure

Alerting	Sound No sound
Cueing	Valid Invalid None
Target	Congruent =Saccade Incongruent =Antisaccade

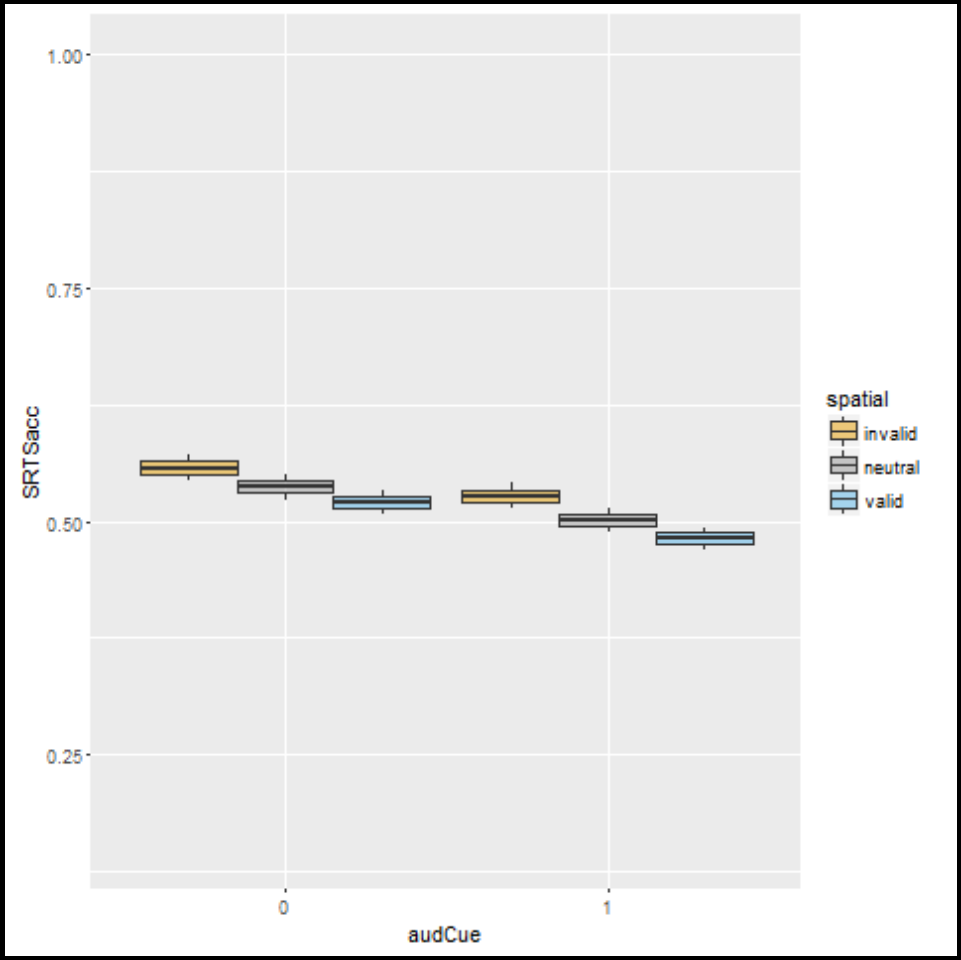


Participants

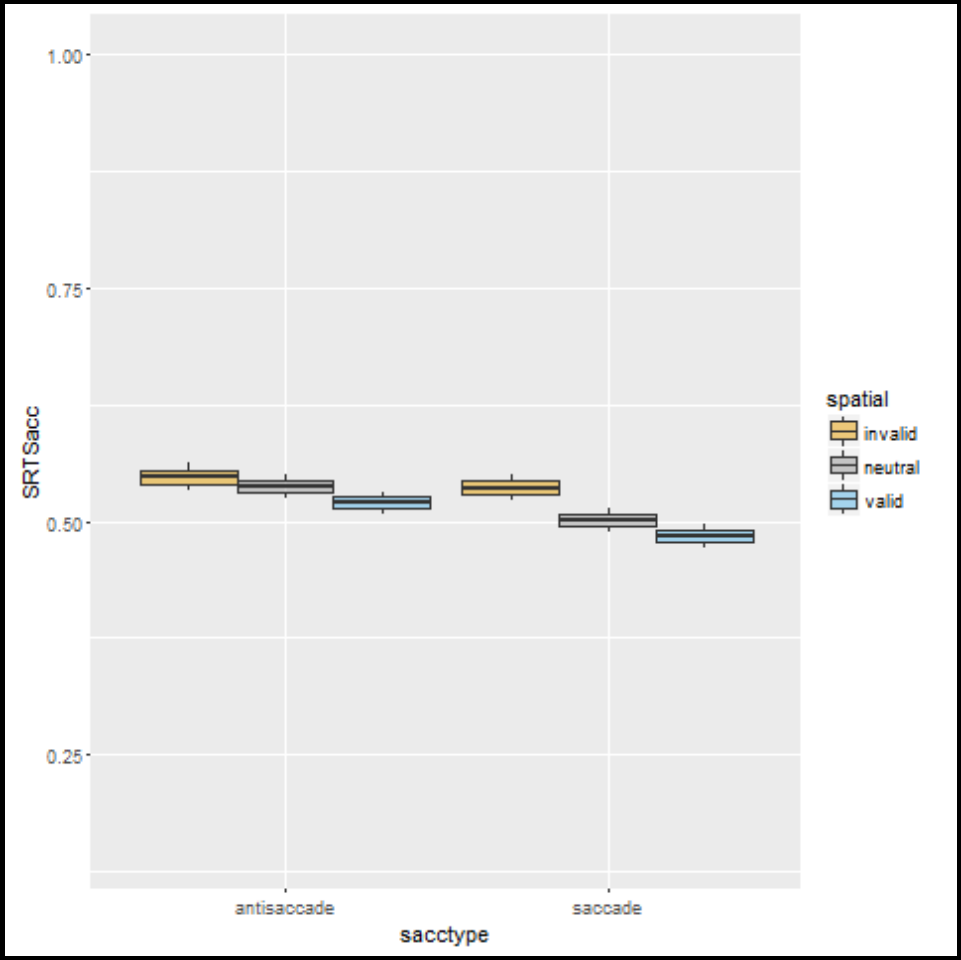
- N=20 (13 - female, 7- male)
- Age range: 20-35
- Corrected or normal vision

- No other restrictions

ANT-S: Result


1.00
0.75
0.50
0.25
SRTSacc
0
1
audCue
spatial
invalid
neutral
valid

ANT-S: Result


1.00
0.75
0.50
0.25
SRTSacc
antisaccade
saccade
sacctype
spatial
invalid
neutral
valid

Conclusions so far

?

Computational modeling

Drift-diffusion model {RT-distribution: mu, sd, acc, skew} <- 2AFC

- Accurate in RT modeling
- Speed-accuracy trade-off accurate
- Neurally plausible (FFI, SC)
- Restrictions: (1) response ≤ 1500ms; (2) single-step decisions

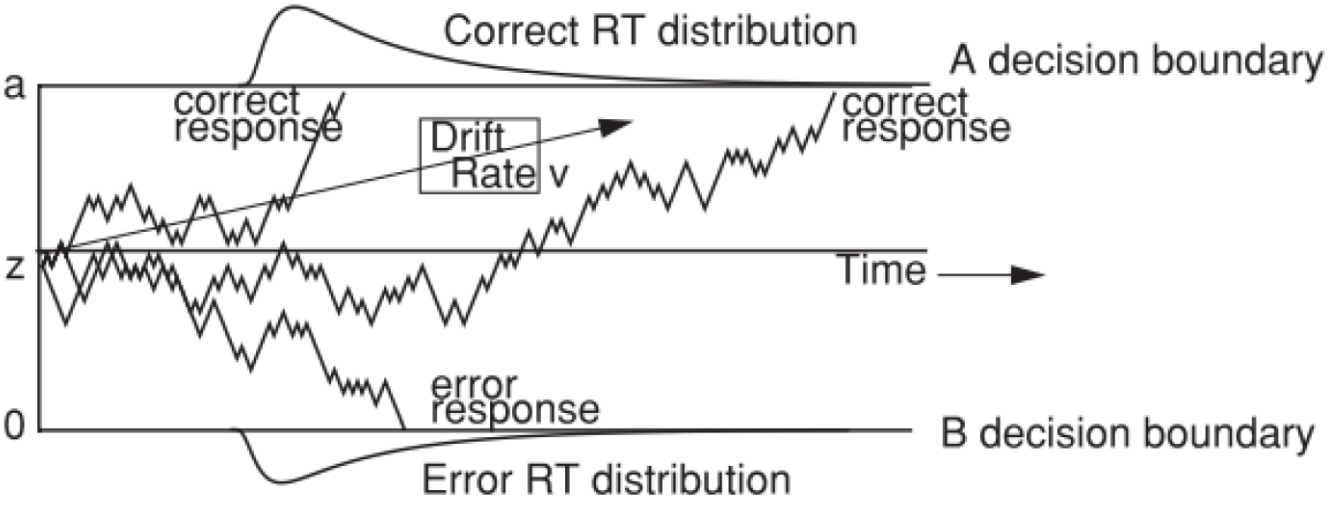


Fig.1 – Decision-making process through drift-diffusion model [from Ratcliff, McKoon, 2008].

References

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