THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Simultaneously modeling the cognitive and neural mechanisms involving different types of expertise in mental rotation

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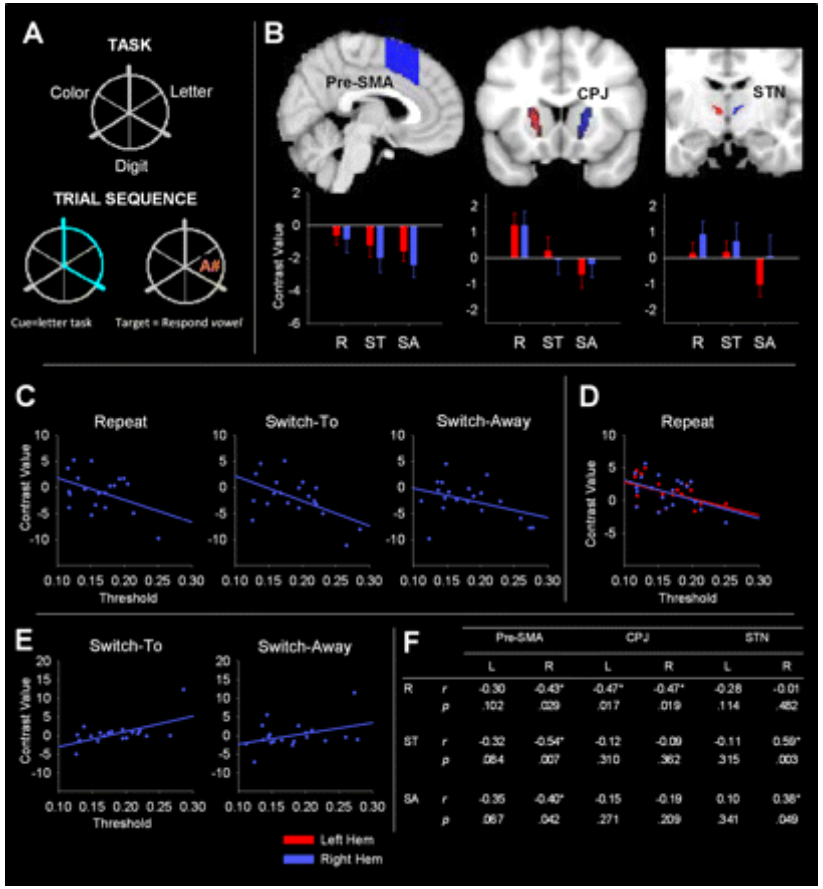
HMRI Hunter Medical Research Institute

NSW GOVERNMENT Health Hunter New England Local Health District

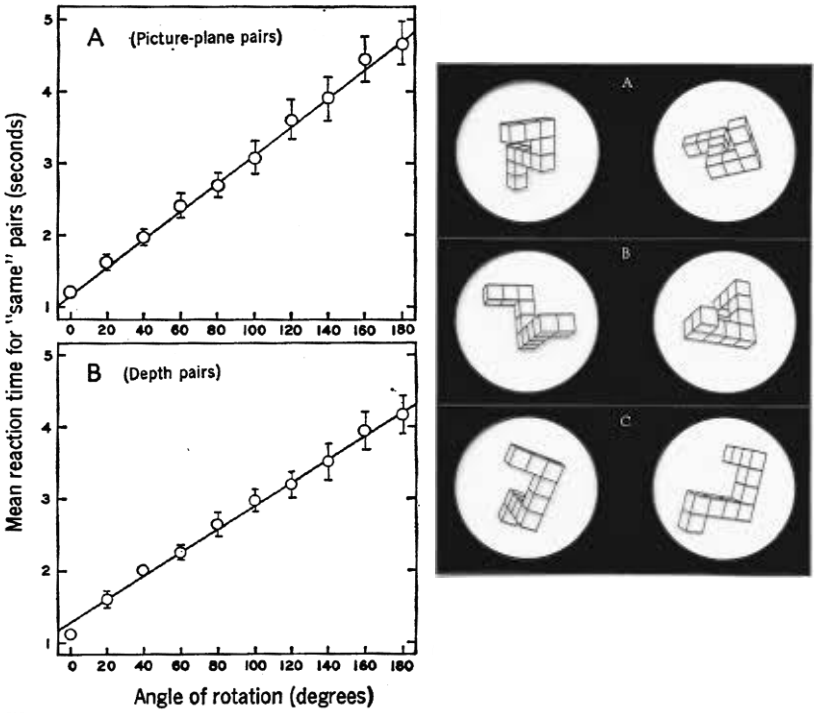
ICON Brisbane July 2014

Top Down modeling approach

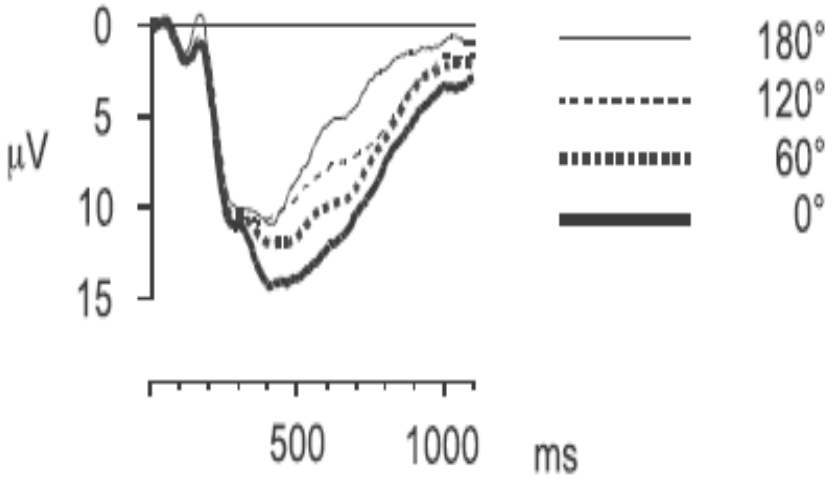


Example of model parameters correlated with cognitive model from Mansfield et al 2011 (with Birte!)

Mental Rotation

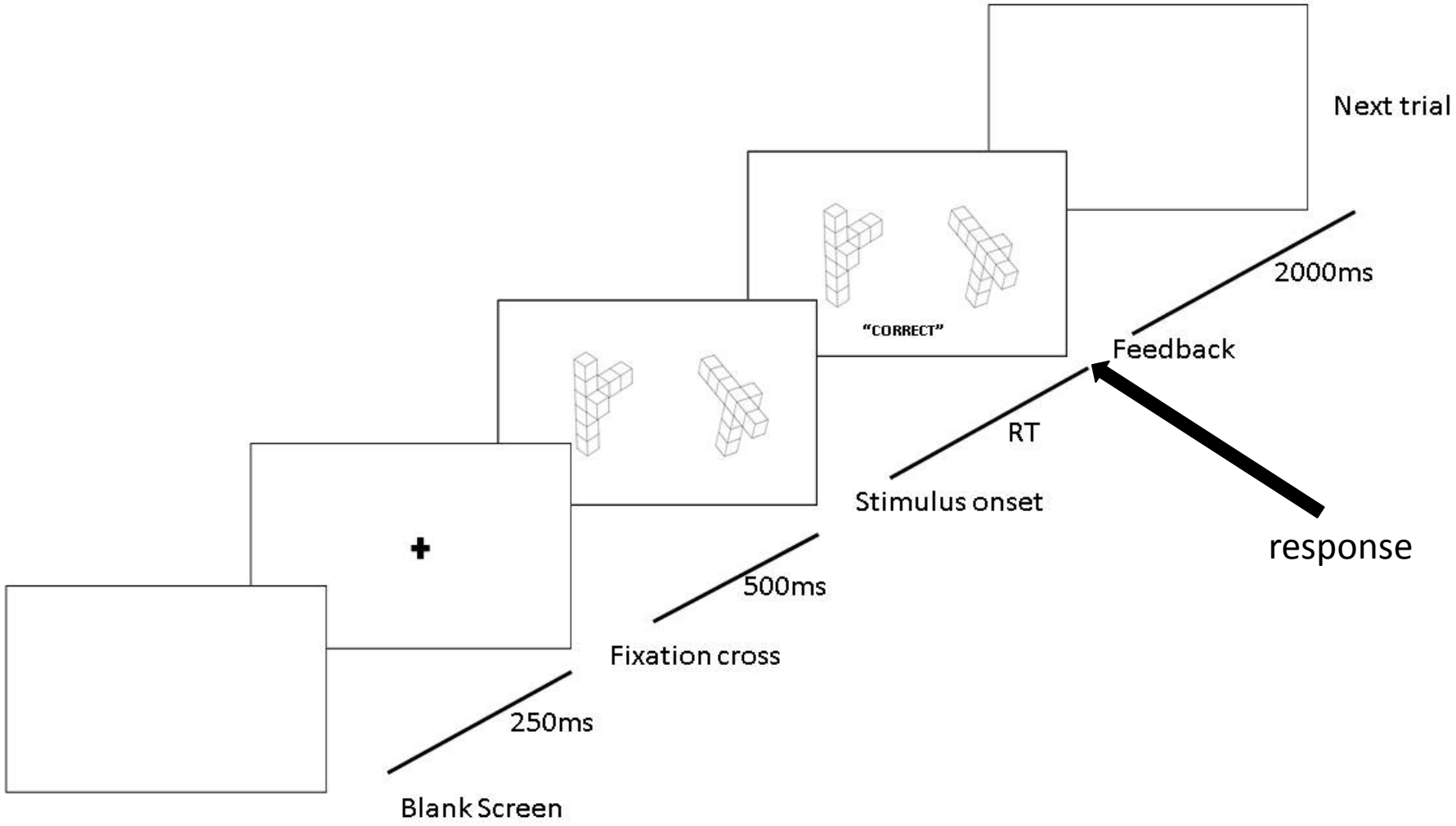


Behavioural results and stimuli from Shepard and Metzler (1971)

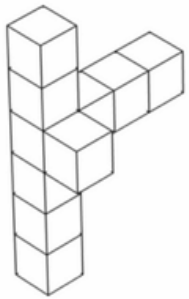


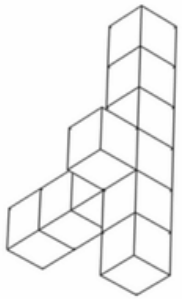
ERP figure from Heil, M. (2002), Mental rotation RRN with alphanumeric characters at Pz showing increased modulation of P3b with increasing angle

Mental Rotation Paradigm



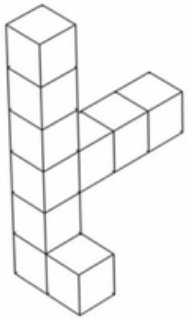
Mental Rotation Paradigm

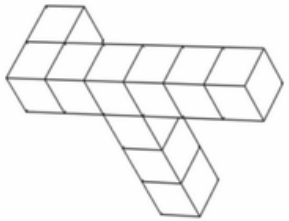




SAME OR DIFFERENT?

SAME OR DIFFERENT?





Model based approaches.

Memory & Cognition
2010, 38 (2), 206-220
doi:10.3758/MC.38.2.206

A model of rotated mirror/normal letter discriminations

EVA KUNG AND JEFF P. HAMM
University of Auckland, Auckland, New Zealand

Mem Cogn (2012) 40:594–613
DOI 10.3758/s13421-011-0172-2

Individual differences in the mixture ratio of rotation and nonrotation trials during rotated mirror/normal letter discriminations

Jordan A. Searle · Jeff P. Hamm

arnal of Experimental Psychology:
uman Perception and Performance
14, Vol. 40, No. 3, 1072–1091

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0096-1523/14/$12.00 DOI: 10.1037/a0035648

Deconstructing Mental Rotation

Axel Larsen
University of Copenhagen

A random walk model of the classical mental rotation task is explored in two experiments. By assuming that a mental rotation is repeated until sufficient evidence for a match/mismatch is obtained, the model accounts for the approximately linearly increasing reaction times (RTs) on positive trials, flat RTs on negative trials, false alarms and miss rates, effects of complexity, and for the number of eye movement switches between stimuli as functions of angular difference in orientation. Analysis of eye movements supports key aspects of the model and shows that initial processing time is roughly constant until the first saccade switch between stimulus objects, while the duration of the remaining trial increases approximately linearly as a function of angular discrepancy. The increment results from additive effects of (a) a linear increase in the number of saccade switches between stimulus objects, (b) a linear increase in the number of saccades on a stimulus, and (c) a linear increase in the number and in the duration of fixations on a stimulus object. The fixation duration increment was the same on simple and complex trials (about 15 ms per 60^0), which suggests that the critical orientation alignment take place during fixations at very high speed.

Keywords: mental rotation, eye movements, visual working memory, random walk

Mental Rotation Transfer

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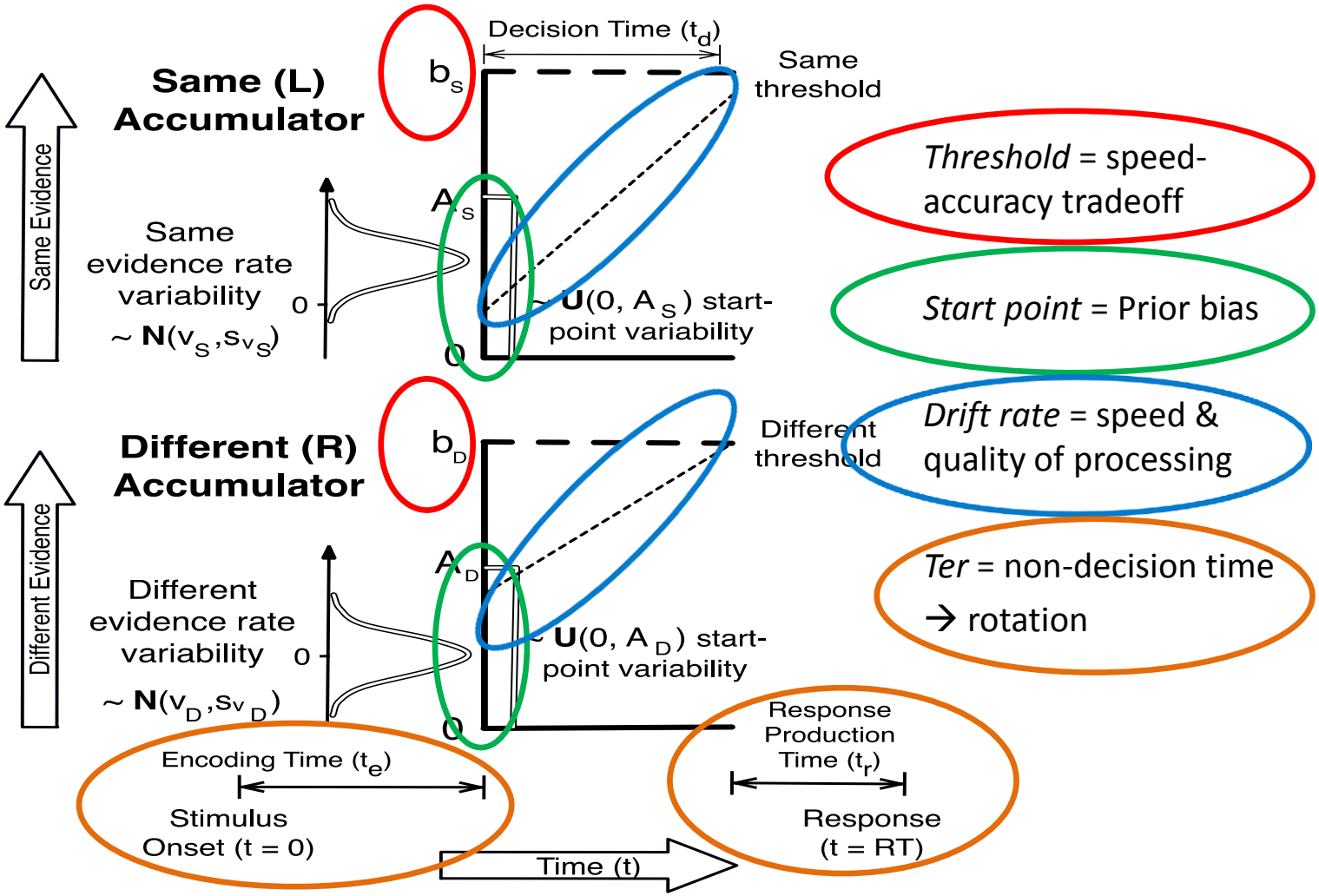
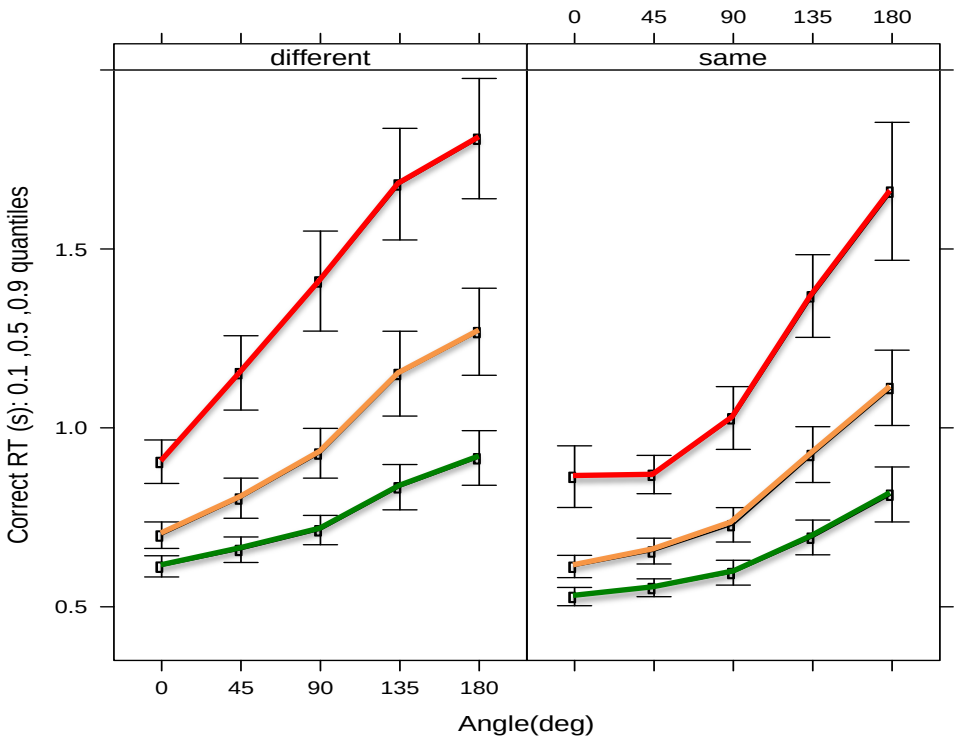
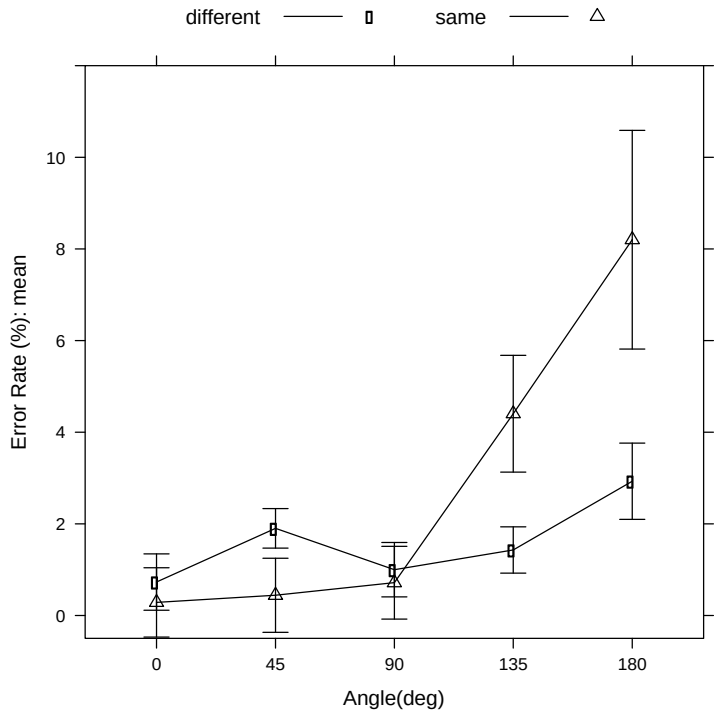
LBA/decision process



Correct RT and Error





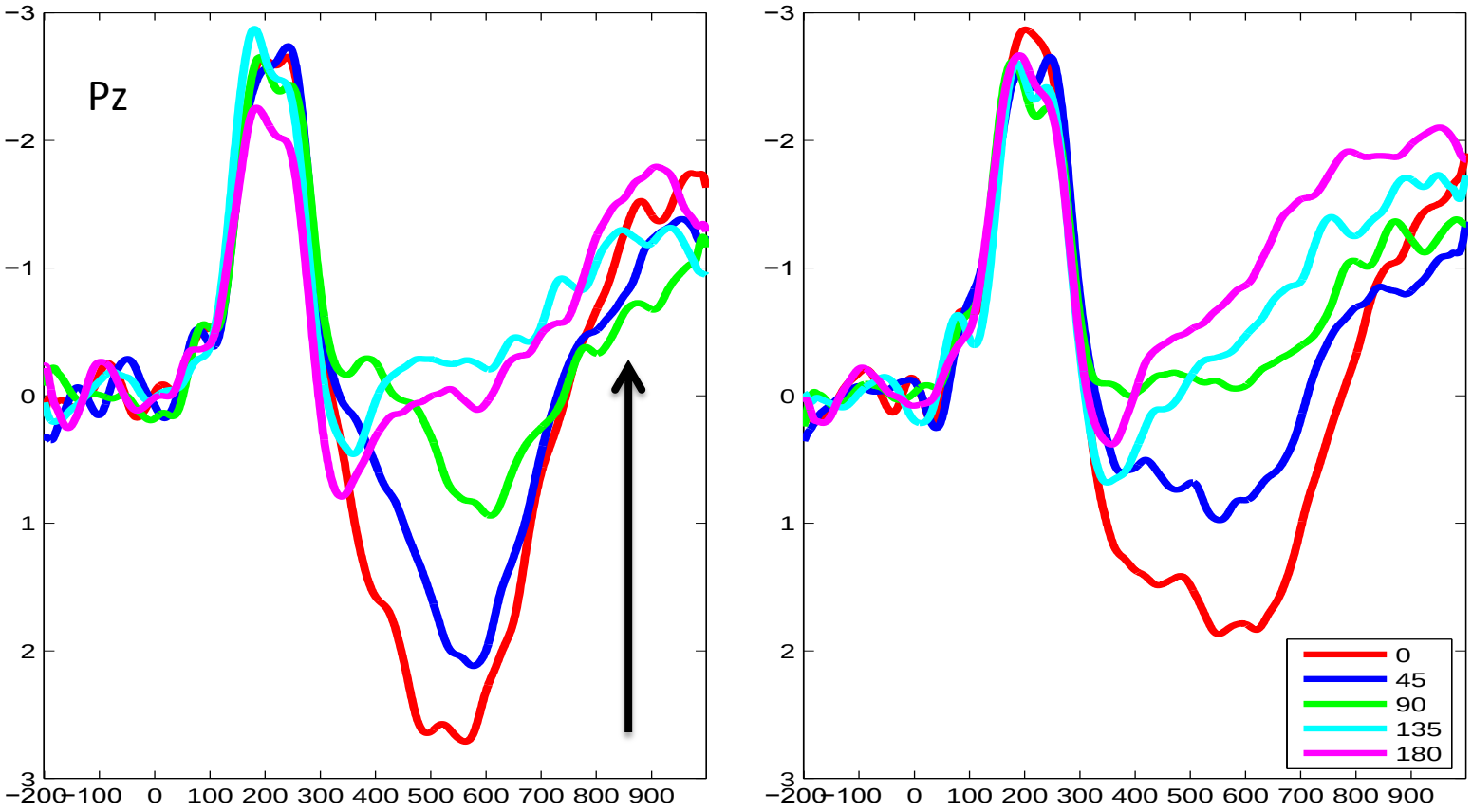
.9 Quantile

Median

.1 Quantile

Quantiles used to describe the spread of the RT distribution

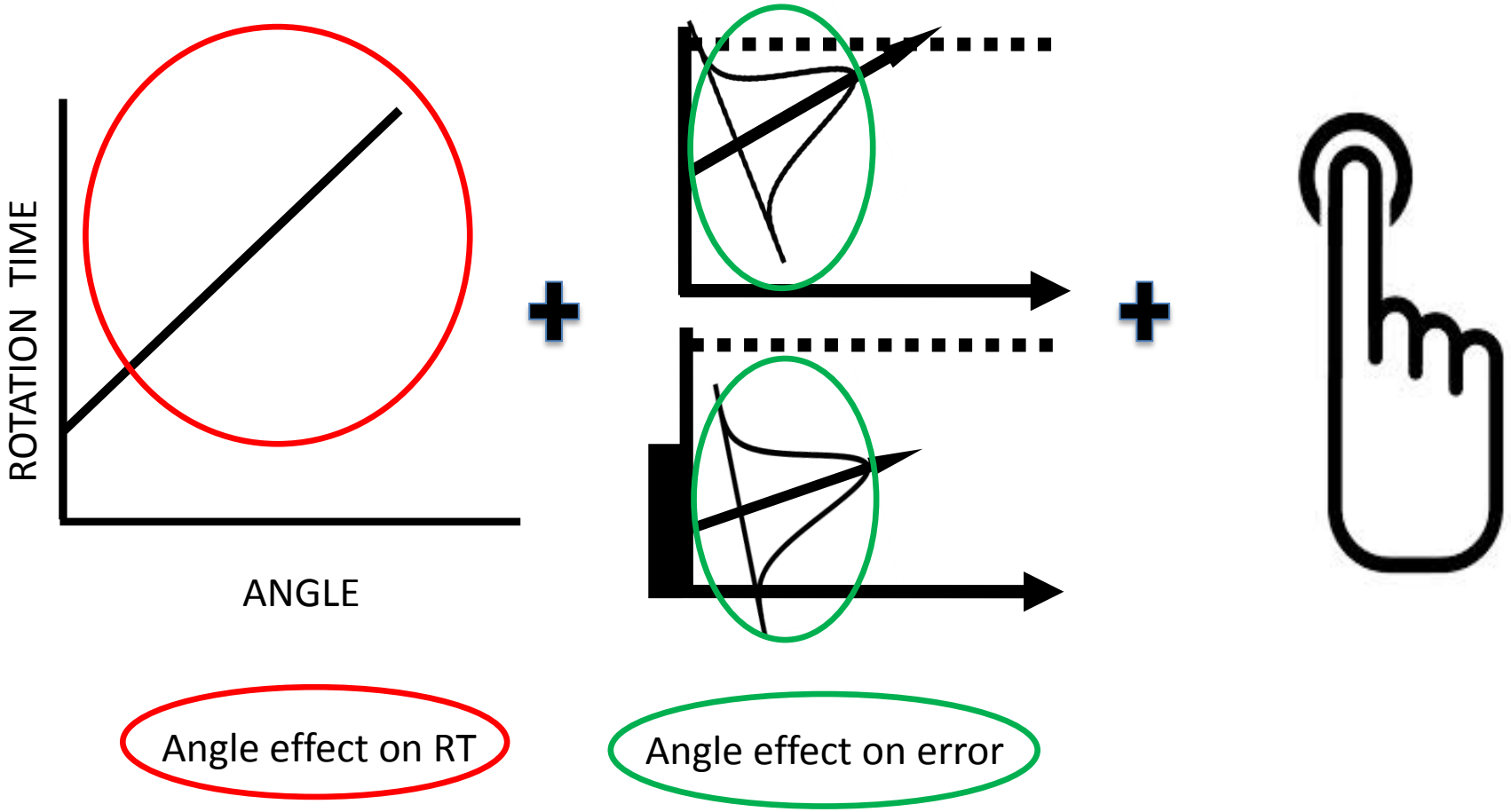
Event Related Potentials



SAME

DIFFERENT

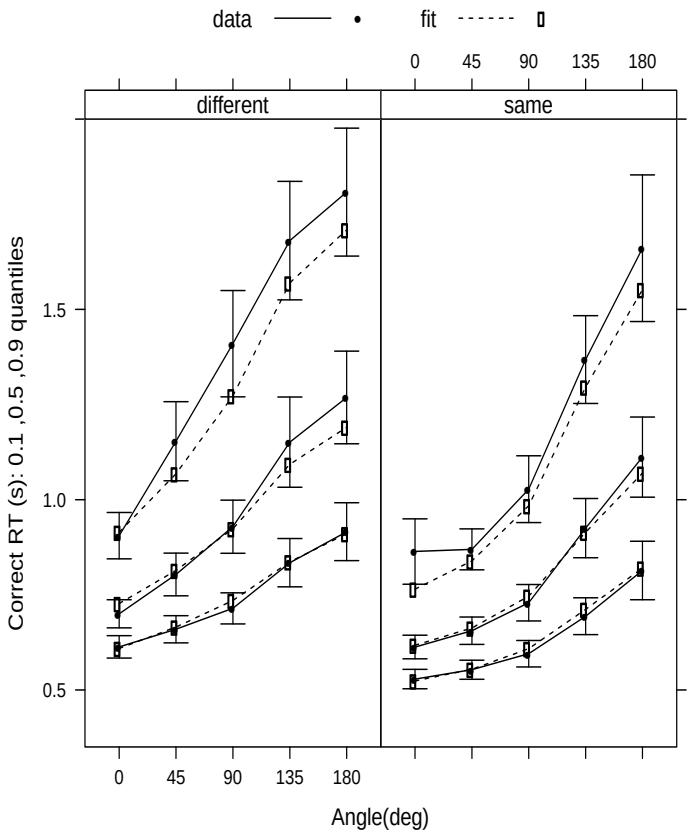
Mr2L


ROTATION TIME
ANGLE
Angle effect on RT
Angle effect on error

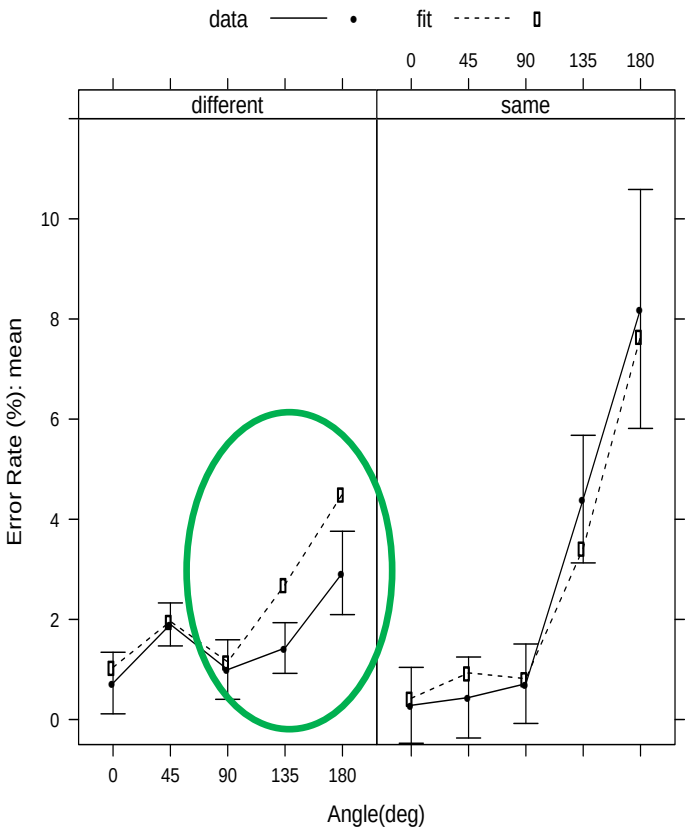
Mr2L

- B bias to Same
- V all factors
- Sv response
- **Ter ANGLE**

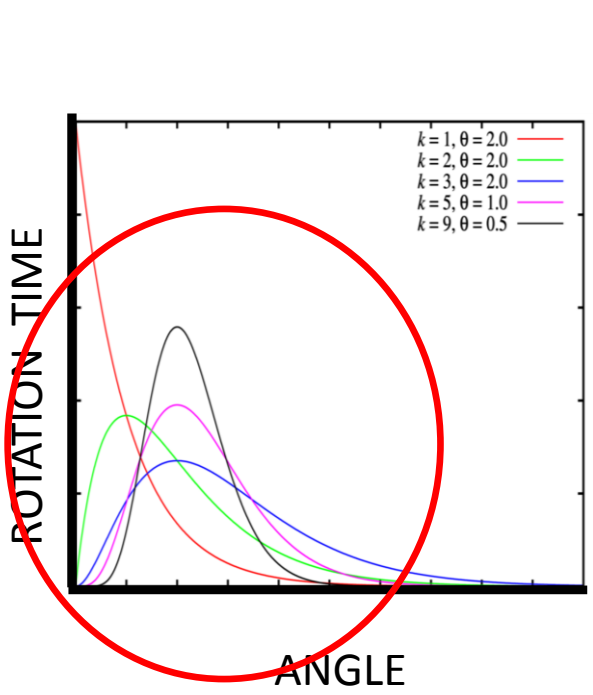
Quantile RT

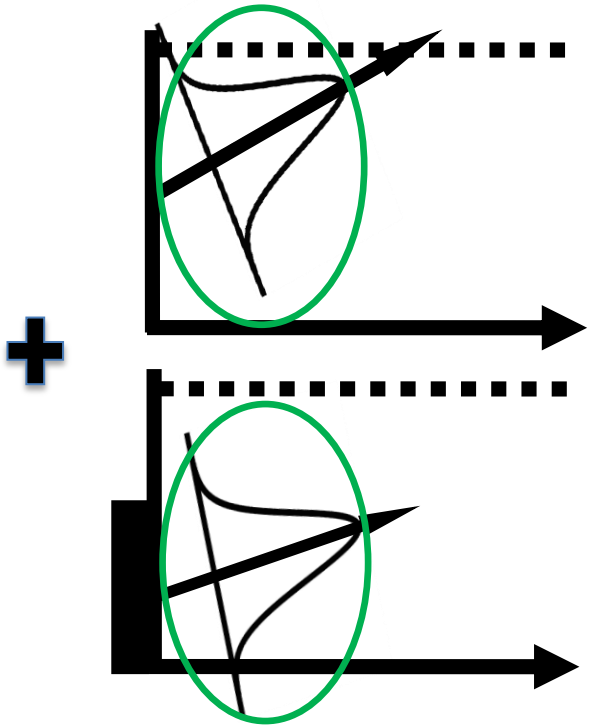


Errors



Models of MR





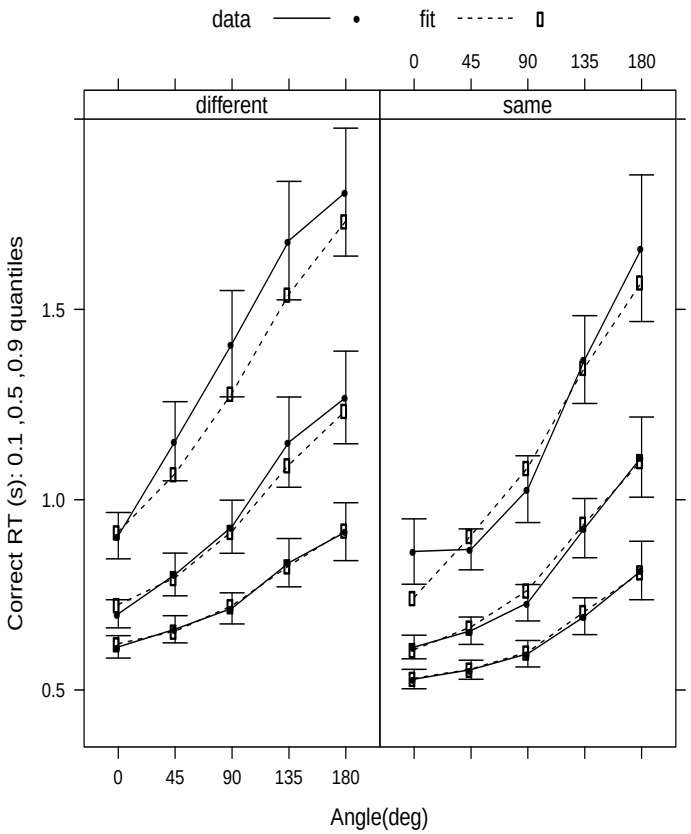
Angle effect on RT

Angle effect on error

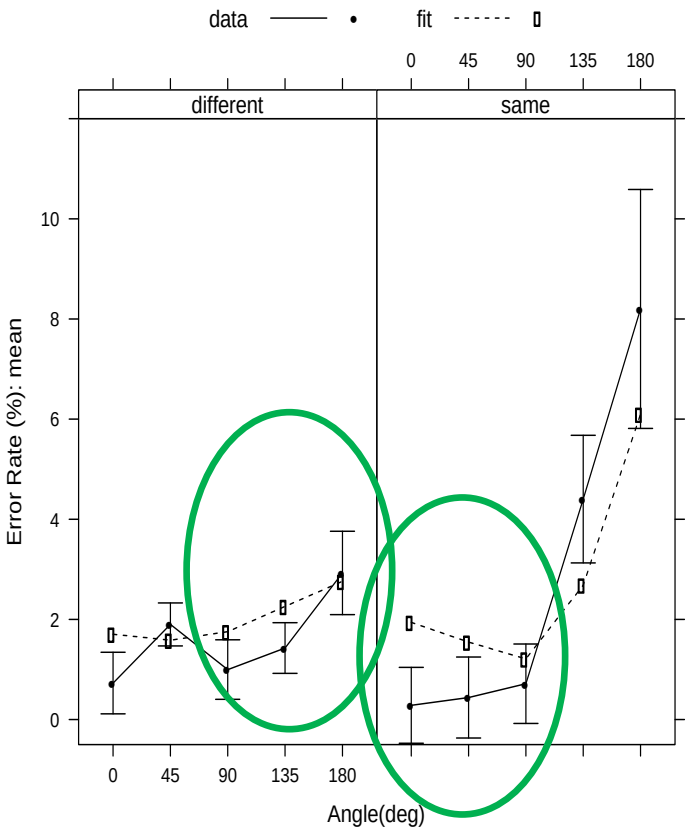
Models of MR – Mr2G

- B bias to Same
- V all factors
- Sv response
- **Ter SCALE and SHAPE gamma**

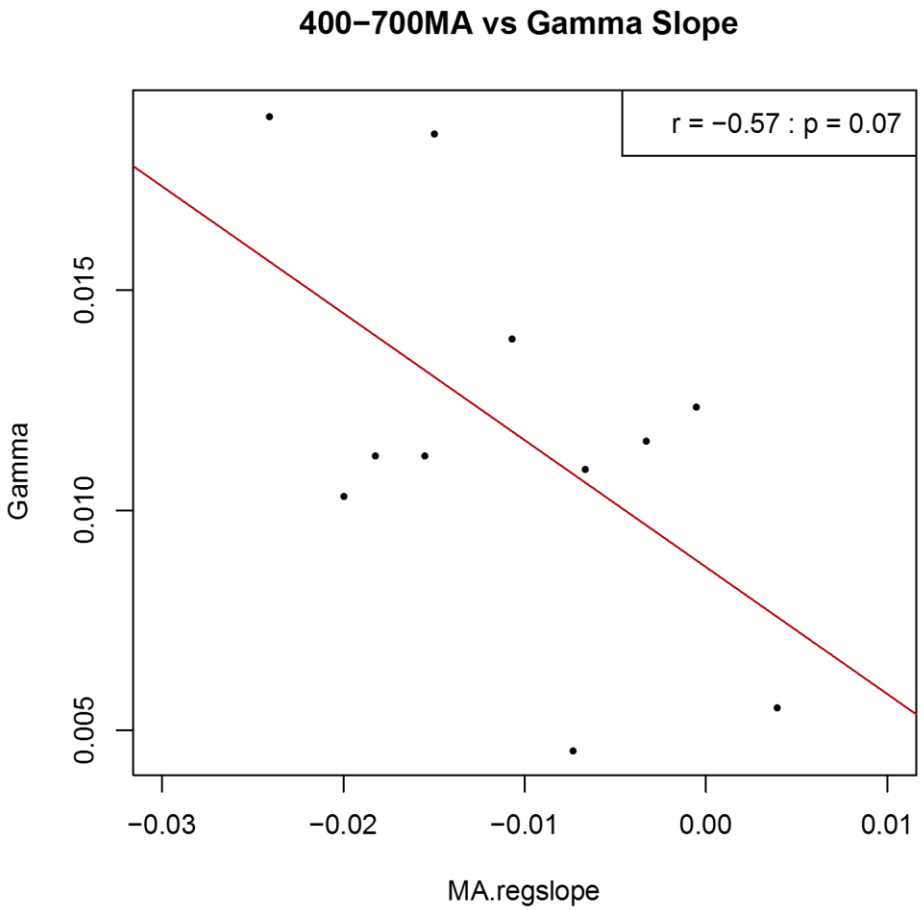
Quantiles

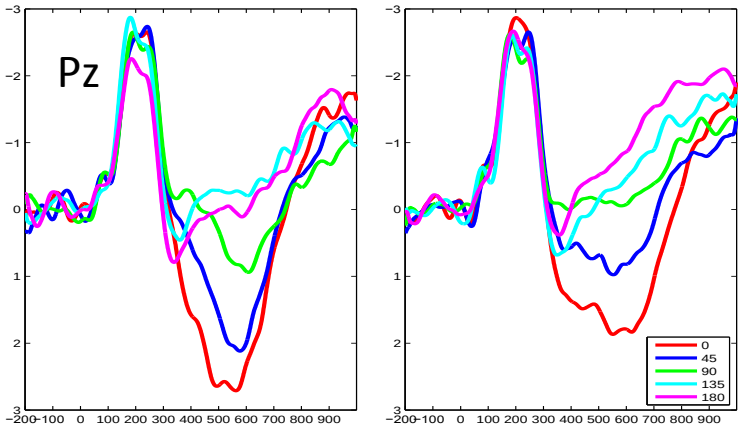


errors

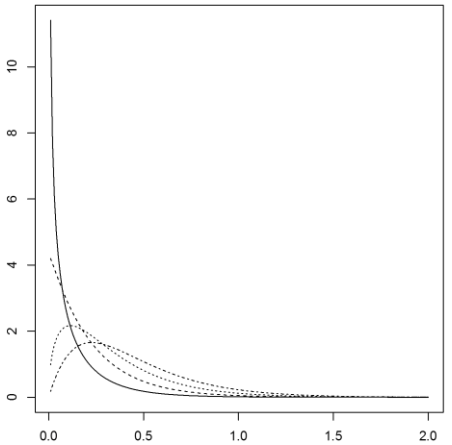


ERP-latent correlation



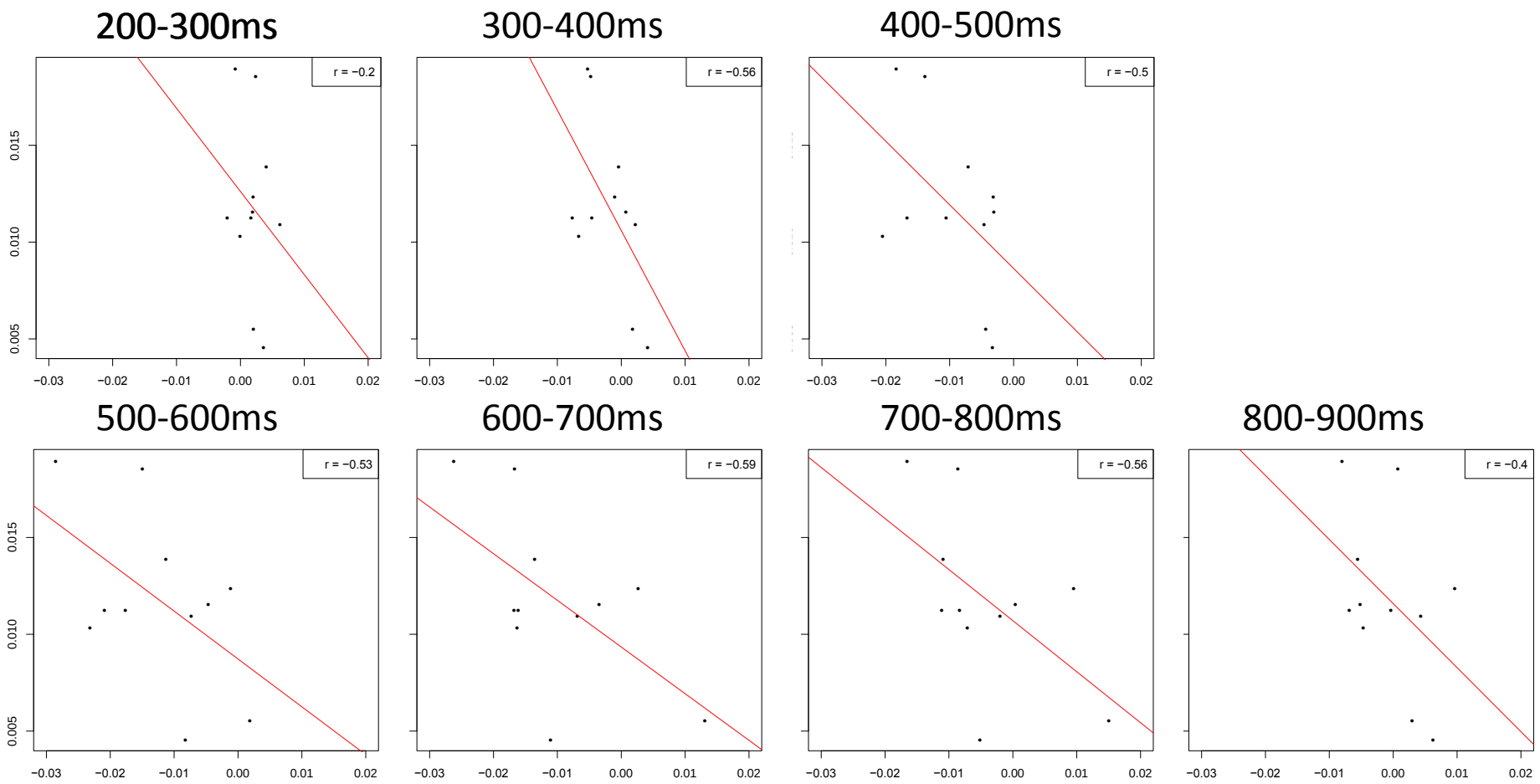


SAME DIFFERENT

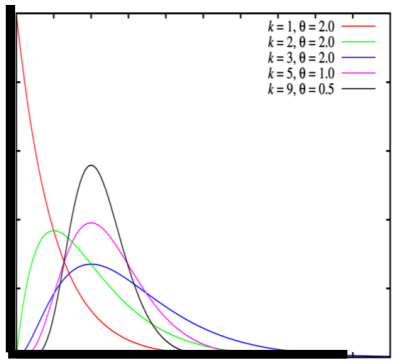


Mean gamma distributions

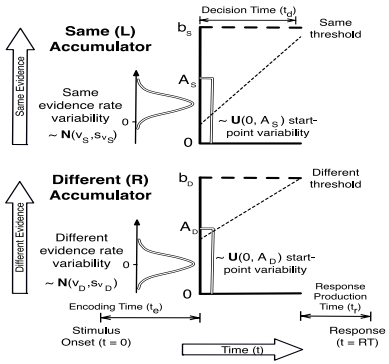
ERP-latent correlations

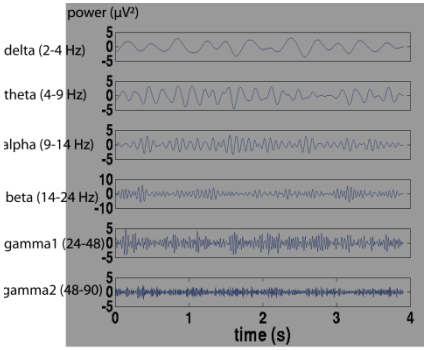


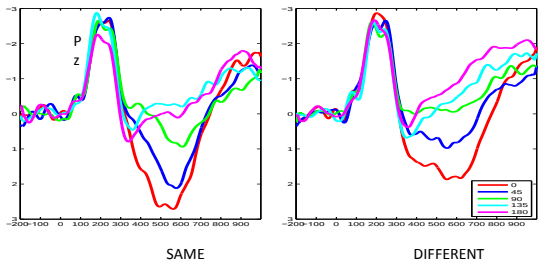
Summary



ANGLE







x = WOW!

Acknowledgements

Thanks to:
Graciela Tesan
Chris Sewell
David Elliott
Melanie Reid
Kanazawa Institute of Technology

Scott Brown

http://newcl.org/provost

Funded by: pilot grants from Macquarie University and the University of Newcastle and by Australian Research Council (grants DP110100234 and LEO668421)

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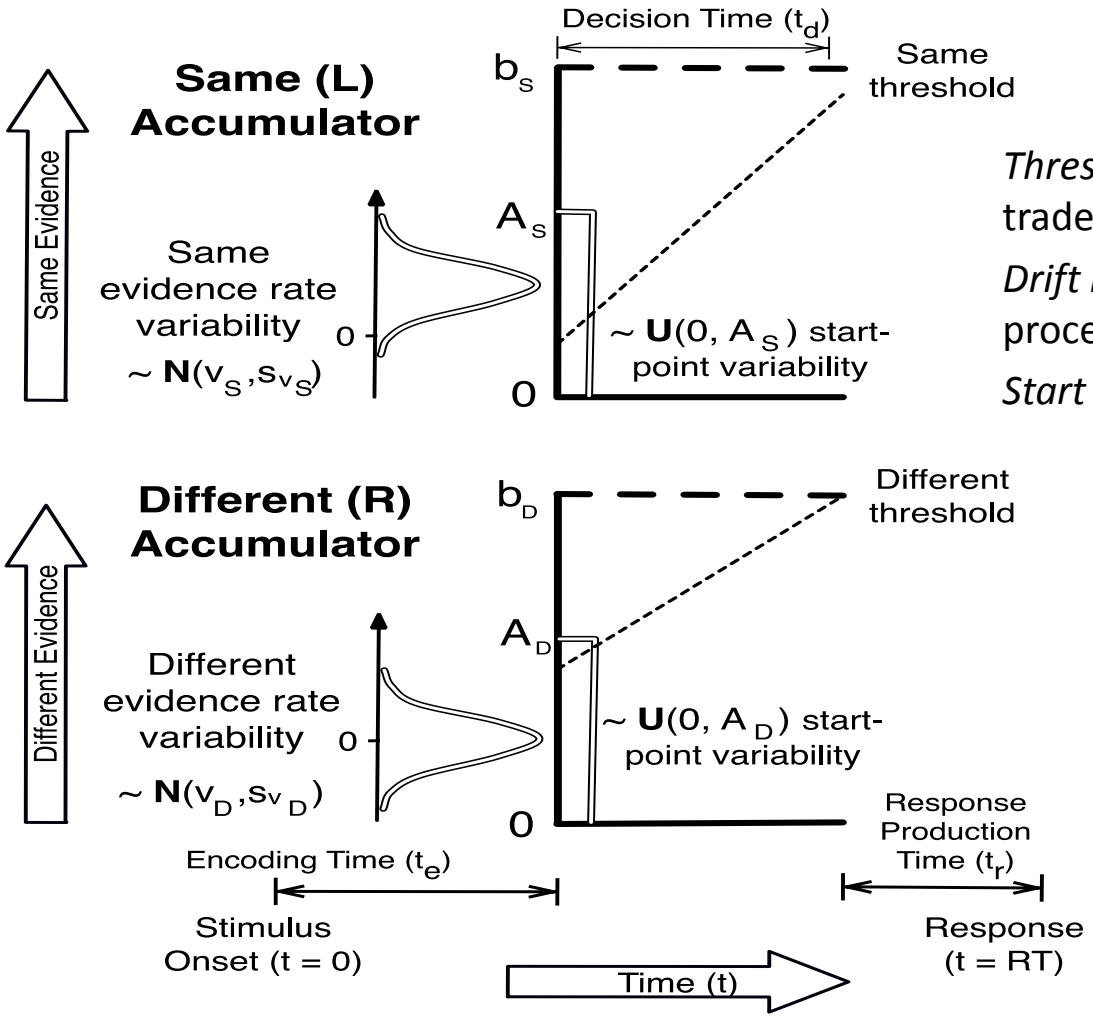
LBA/decision process



Threshold = speed-accuracy tradeoff

Drift rate = speed & quality of processing

Start point = Prior bias

Models of MR – MR2gi

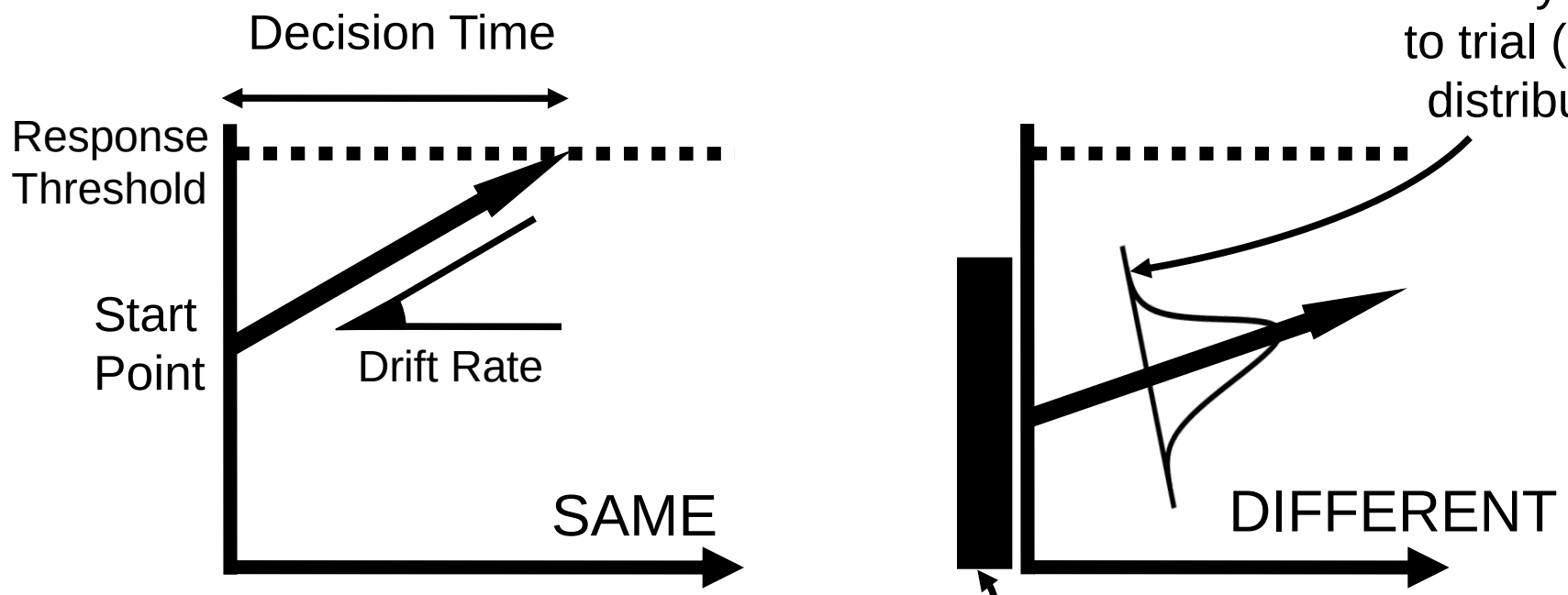
B~lR & A~1 & v~P*A*S*C & sv~C & ter~1 & st0~1 & AS~1 & AI~1 & pc~1

Quantiles

Error

Comparison

LBA/decision process



Drift rates vary randomly from tria to trial (normal distribution).

Start points vary randomly from trial to trial (uniform distribution).

NOISE PROCESSES:
Start Point is a_i ~ Uniform(0,A)
Drift Rate is d_i ~ Normal (d,s)