Sphere in a Box: Psychophysical experiments in reality close context

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Introduction

Psychophysical experiments are designed to provide highly precise parameter estimations. Thus, numerous highly controlled trials are needed in an isolated enviroment. But due to this setting we loose realism, because in nativ environment we always have many confounding variables and a more complex visual stimulus. So our approach to get more reality close results is to embedd the experiment in a game-engine created surrounding with Unreal4.

Theory

Visual attention can be understood as biased competition.

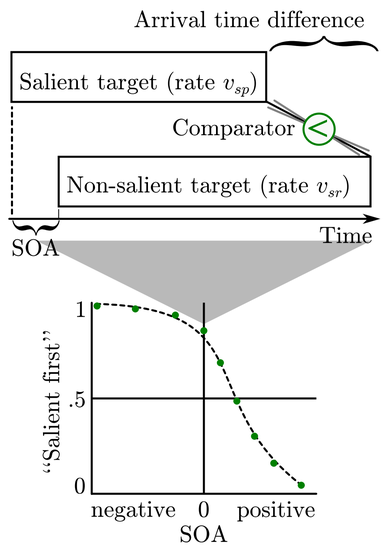
- stimuli “race” in parallel for brain’s limited resources
- competition is biased by relevance and visual contrast

Bundesen’s (1998) theory of visual attention (TVA) models this mathematically

- parameter C, overall processing rate, models available resources
- parameter w, attentional weight, models attentional bias

TVA can be applied to temporal-order judgments to measure attention (Krüger, Tünnermann, & Scharlau, 2016)

- only two relevant stimuli for judgment (salient probe *p*, non-salient reference *r*)
- order judgment is interpreted as outcome of two TVA races at speed (rate) v_p and v_r



$$v_p = w_p \cdot C$$

$$v_r = w_r \cdot C$$

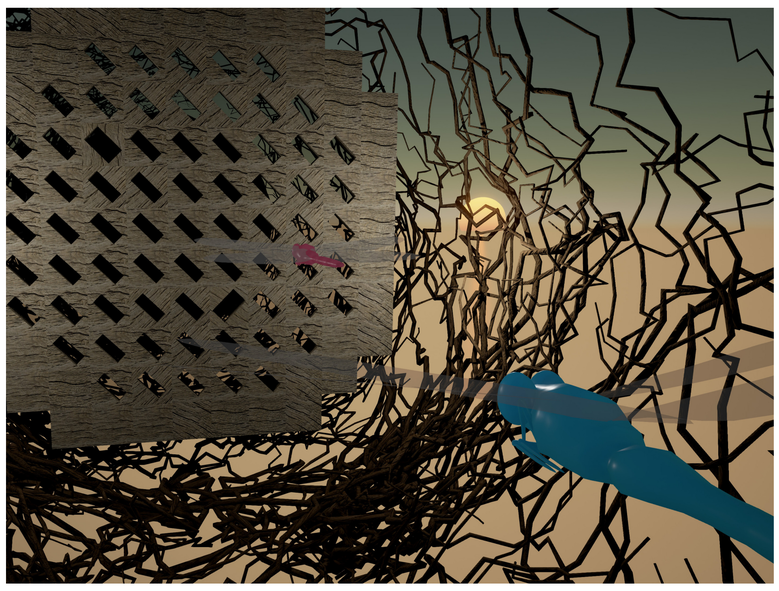
$$w_r = 1 - w_p$$

$$w_p = \kappa_p \sum_{j \in R} \eta(p, j)\pi_j$$

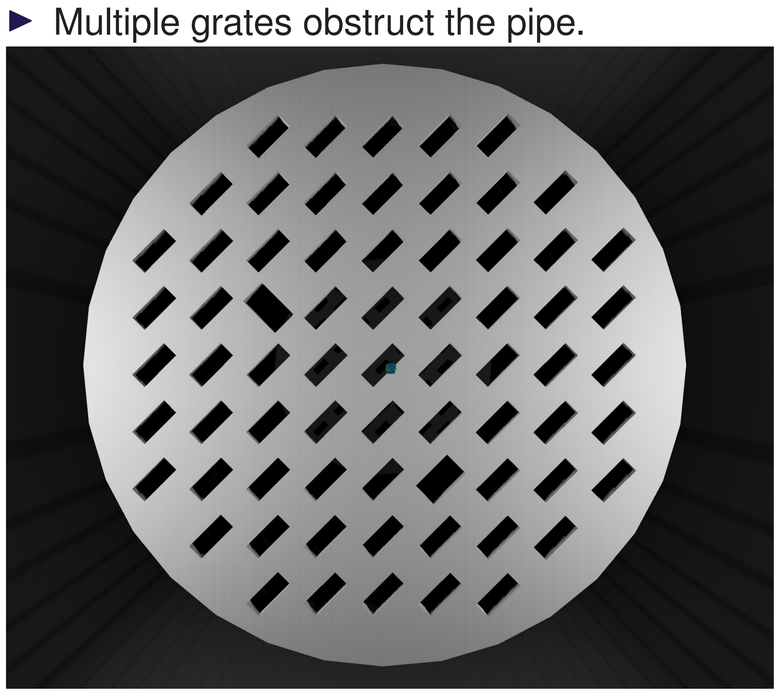
The Game and the experiment measure w, attentional weight, and C, overall processing rate, from temporal-order judgments.

Game

- Dragonfly race through a pipe.



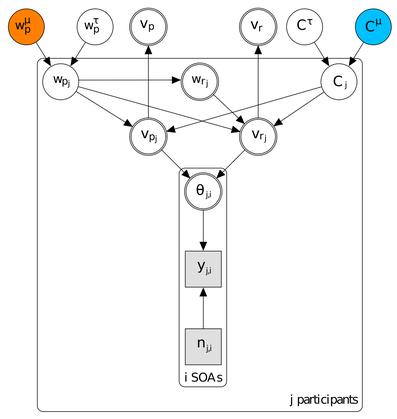
- Multiple grates obstruct the pipe.



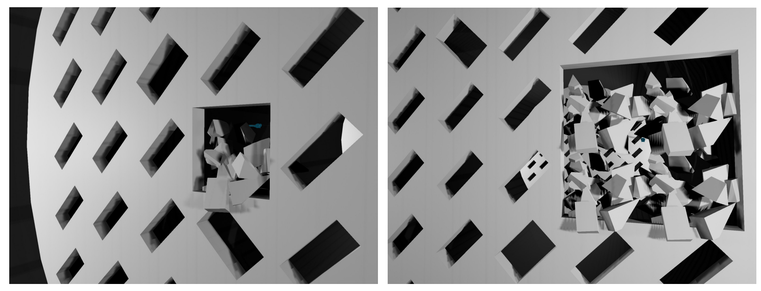
- Flying through two special openings provides bonuses.
- Discriminating their flicker correctly in time and flying through them accordingly increases bonus.

Analysis

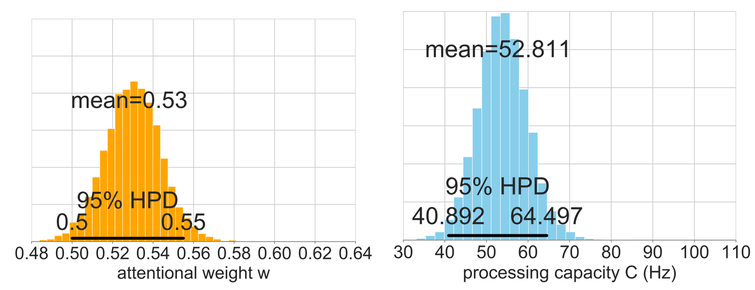
- Theory-based TVA parameters and data were connected by a Bayesian hierarchical model.



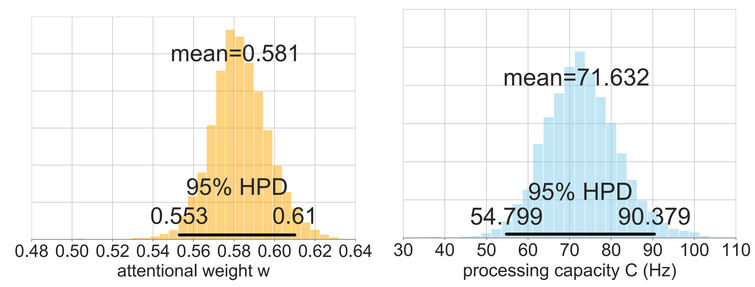
- Repetitions of trials per participant vary because of the freedom in the game – difficult to model with classical statistics.



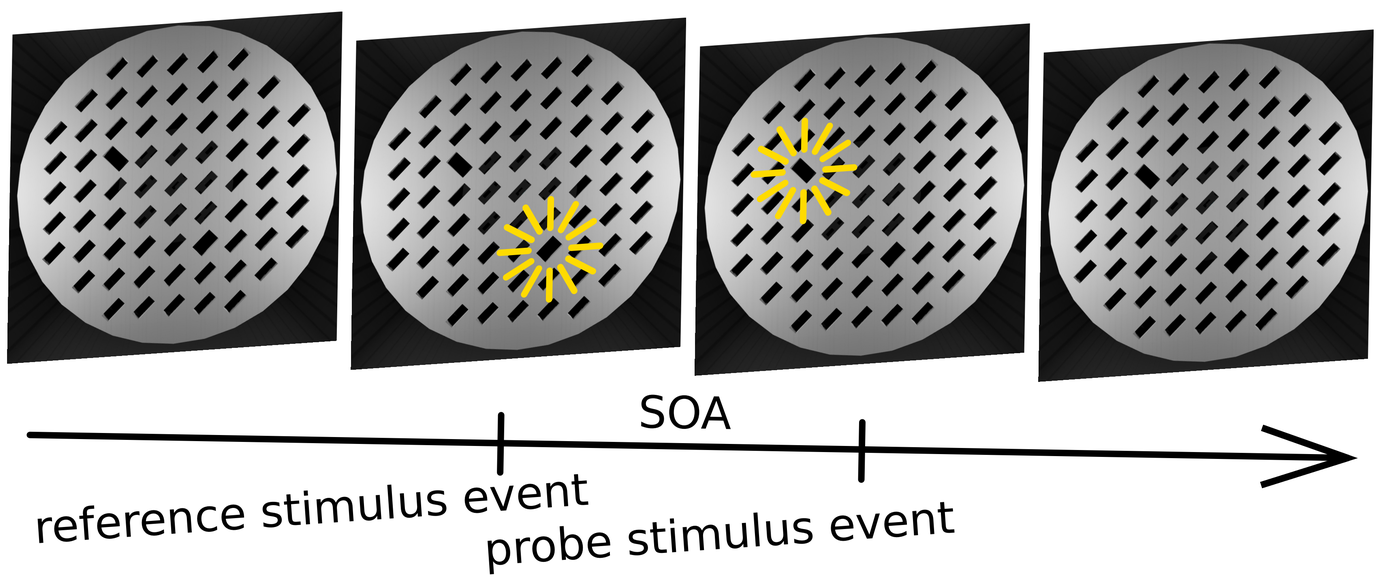
- psychophysical parameter estimation: game (19 participants, ongoing)



- psychophysical parameter estimation: classical experiment (13 participants, ongoing)



Procedure (game and classical experiment)



Conclusion

The results from the game and the classical experiment are similar: The salient probe stimulus receives an increased attentional weight in contrast to the reference stimulus. Importantly, estimation accuracy was comparable.
Quantitatively, there is a difference: In the game, the probe stimulus receives less attention and the overall visual processing capacity is reduced that may be caused by the necessity to visually monitor the position of the dragonfly. This requires capacity and attention to be distributed among three instead of two positions.
We conclude that the gaming approach is viable in general and that Bayesian data analysis allows for precise estimation despite the freedom in games.

References

Bundesen, C. (1998). A computational theory of visual attention. *Philosophical Transactions of the Royal Society of London B: Biological Sciences, 353, 1271-1281.*, doi: 10.1098/rstb.1998.0282

Krüger, A., Tünnermann, J., & Scharlau, I. (2016). Fast and conspicuous? Quantifying salience with the theory of visual attention *Advances in Cognitive Psychology, 12(1), 20*, doi: 10.5709/acp-0184-1