Understanding the influence of perceptual noise on visual flanker effects through Bayesian model fitting

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A common experimental paradigm to investigate visual selective attention is the flanker task (Eriksen & Eriksen, 1974). In a typical flanker experiment, participants must respond to a central target (e.g., a letter "H") flanked by two other objects (e.g., letter "S"). The 'flanker effect' refers to a decrease in performance when the flankers require a different response to that of the target (incongruent trials), compared to when all objects are linked to the same response (congruent trials). In a recent series of studies, we investigated the influence of perceptual noise in a flanker task using random-dot-kinematograms (RDKs; e.g., Deakin & Heinke, 2020; see Fig. 1). In addition to perceptual noise (motion coherence), the spacing between stimuli (narrow and wide) was also manipulated.

To understand our experimental results, we fitted White, Ratcliff & Starns' (2011) Shrinking Spotlight (SSP) model using approximated Bayesian computation (ABC) based on Kernel Density Estimation (KDE) and differential evolution Markov Chain Monte Carlo (DE-MCMC) (e.g., Narbutas et al., 2017). SSP uses a drift diffusion approach to implement the spotlight (or zoom lens) theory with parameters reflecting the shrink rate, perceptual strength of stimuli, initial spotlight width and decision boundary. We also took a rigorous Bayesian approach and designed priors using prior predictive checking. Summary statistics for this step were based on the general knowledge about reaction times in behavioural experiments to create informative priors without pre-empting parameter estimations for our experiment.

Our results (Fig. 3) show that the initial spotlight width decreases as coherence increases while higher coherence is linked to greater perceptual strength. These findings are consistent with the idea that attention can be constrained to the target at high coherence, and attention only goes "elsewhere" when perceptual strength is low. Also note that the decision boundary decreases with increasing coherence consistent with idea that decision boundary measures participants' confidence.

In our talk we will discuss other models of the flanker task and compare their ability to explain our data using marginal likelihood. Finally, it is worth noting that our approach can be used for a range of complex (neural) models as the approach is based on approximated Bayesian computation.

Fig. 1 Illustration of stimuli in the RDK-flanker task.

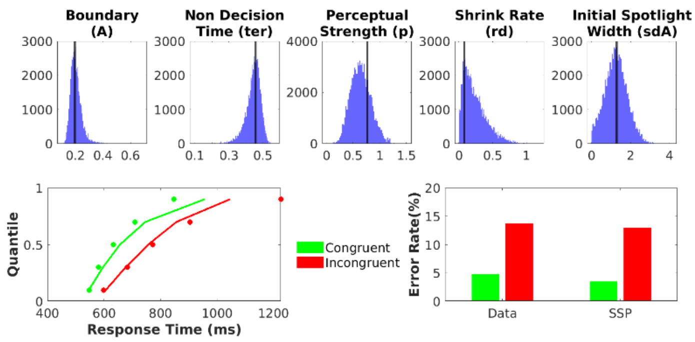

Fig. 2 Results for 60% coherence and narrow spacing. Top row: posterior distributions. Bottom row: Illustration of quality of fit.

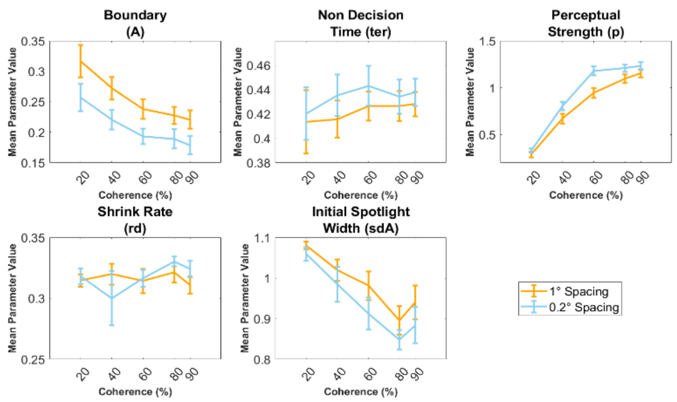

Fig. 3 Parameter estimations. Error bar indicates the standard error based on individual differences.

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