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RF shape channels: The processing of compound Radial Frequency patterns

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INTRODUCTION

- Radial Frequency patterns (RF) have been extensively used to study intermediate stages of shape perception (Wilkinson et al., 1998; Loffler, 2008; Schmidtmann et al., 2012).
- Combinations of RF patterns can be used to investigate natural shapes like faces or fruits/vegetables.
- Previous studies showed evidence that different RF functions are not suited as universal shape descriptors. Complex shapes are unlikely to be encoded by RF functions, because RF patterns are not suited as universal shape descriptors.

AIMS

- To test the multiple RF shape channel hypothesis for a wide range of near-threshold and supra-threshold (high modulation amplitude) shapes.
- To model summation with a Signal Detection Theory (SDT) Additive and Probability Summation Model (Kimdong et al., 2015).

METHODS

\[
\theta = \frac{1}{2} \left( \theta _{1} + \theta _{2} \right)
\]

\[
I(\theta _{1}, \theta _{2}) = \frac{\theta _{1} \theta _{2}}{\theta _{1} + \theta _{2}}
\]

\[
\theta _{1}, \theta _{2} \rightarrow \text{RF}
\]

RESULTS

- PS / AS model under Signal Detection Theory for a 2-IFC task (Kimdong et al., 2015).
- The model calculates the proportion correct based on the PS of n signals presented in n out of 2 spatial locations, with all signals having the same \( \sigma \), for a M-IFC (M-afc) task, under the assumptions of SDT and assuming an unbiased observer.
- PS and AS for unequal stimulus strengths for two summation scenarios termed by Kingdom et al. (2015) 'Matched Attention Window' (MAW) and ‘Fixed Attention Window’ (FAW) (the latter term first proposed by Tyler & Chen, 2000).
- The difference in the two scenarios is reflected in the parameter \( \varnothing \) which indicates the number of channels that are monitored by the observer on each trial.
- In the FAW scenario, the observer only attends to those channels that contain a signal in one or other of the forced-choice pair.
- Given that the component and compound shapes were presented in separate blocks, this is a plausible scenario.
- Under this scenario \( \varnothing \), the number of channels monitored is the same as \( n \), the number of signals.
- Thus for our component data \( \varnothing \) and \( n \) both equal 1, while for the compound data \( \varnothing \) and \( n \) both equal 2.
- However, given that the observers were naive as to whether in each block they were detecting a component or a compound, it is also possible that they monitored on all trials both channels – this is the FAW scenario - in which case \( \varnothing \) is 2 for both components and compounds.
- In the above analyses, we allowed the transducer exponents for the two components to be different.
- However, one could argue that they should be constrained to be equal, so we decided to model one of the naive observer’s (RL) data with this constraint.
- Model comparison: Akaike Information Criterion (Akaike, 1974).

MODEL

- PS / AS model under Signal Detection Theory for a 2-IFC task (Kimdong et al., 2015).
- The model calculates the proportion correct based on the PS of n signals presented in n out of 2 spatial locations, with all signals having the same \( \sigma \), for a M-IFC (M-afc) task, under the assumptions of SDT and assuming an unbiased observer.
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DISCUSSION

- Simulations show that combinations of RF basis functions can only describe a small subset of shapes.
- Due to their mathematical limitations RF basis functions are not suited as universal shape descriptors utilized by the visual system.

References

- Loffler, Vision Research, 2008
- Schmidtmann, Kennedy, Chubb, & Loffler, Vision Research, 2010
- Bell & Badcock, Vision Research, 2006
- Bell, Badcock, Wilson, & Wilkinson, Vision Research, 2007
- Bell, Wilkinson, Wilson, & Badcock, Vision Research, 2009
- Dickinson, Bell, & Badcock, Fluid DNE, 2013
- Tyler & Chen, Vision Research, 2000
- Elder, IEEE Transactions on Automatic Control, 1974