The respiratory cycle modulates cross-modal decision computations

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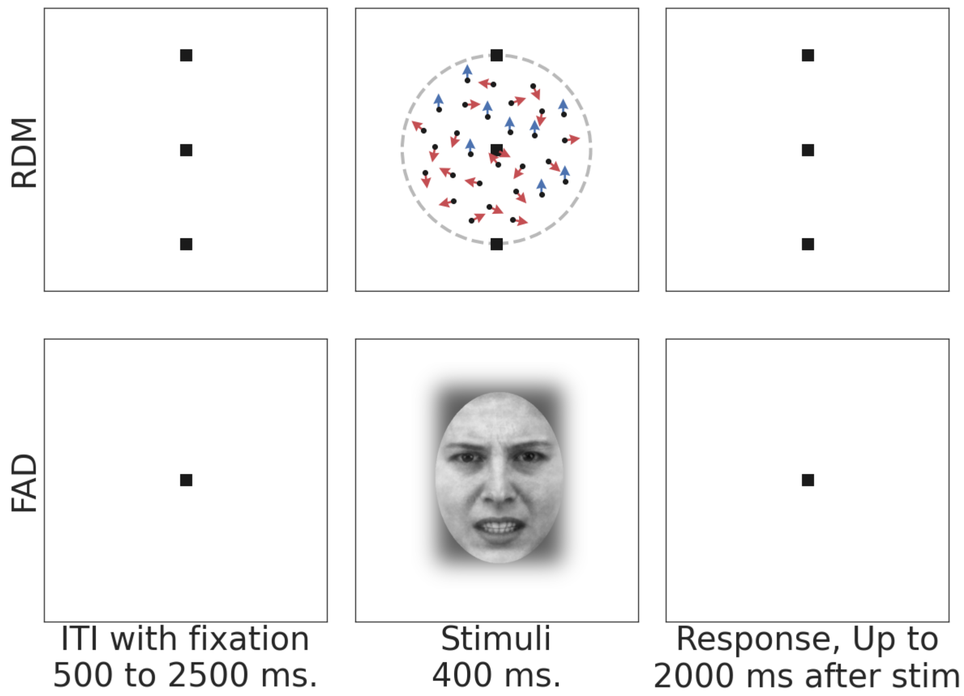
Methods

Psychophysical tasks

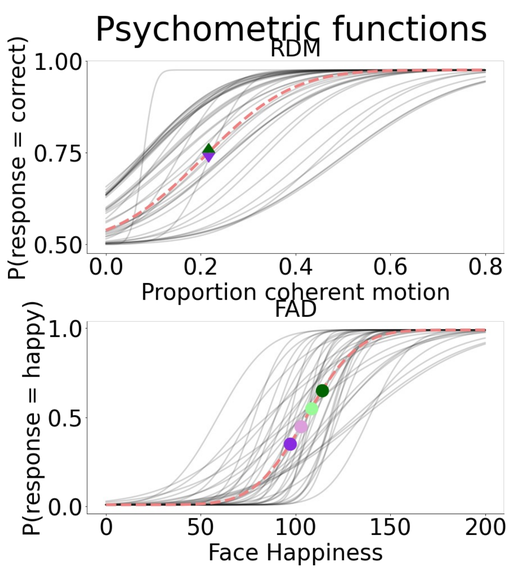
1. **Motion perception (RDM)**
2. **Face affect discrimination (FAD)**

- **41 participants** completed **320 trials of each task**
- Counterbalanced, alternating block design

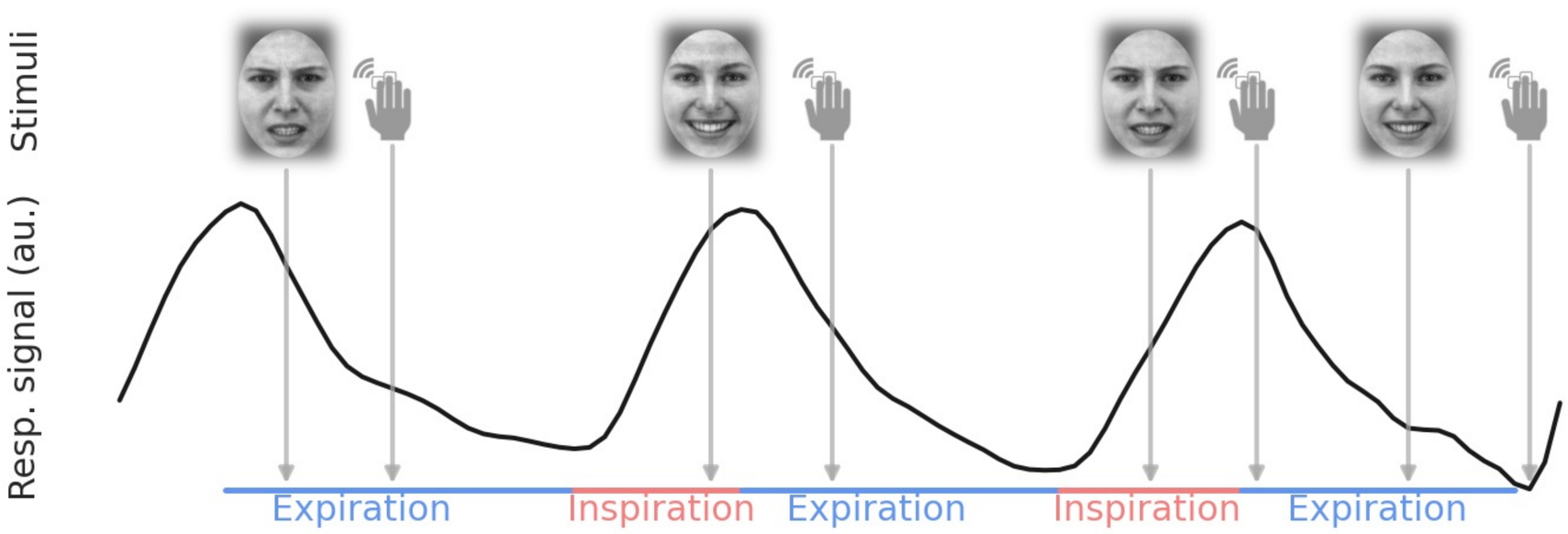


Background: Respiratory rhythms not only play a critical role in homeostatic survival but also modulate other non-interoceptive perceptual and affective processes in the brain. In particular, recent evidence from human and rodent models suggests that both neural and behavioral oscillations are modulated by respiratory phase, i.e. the inspiratory-expiratory cycle. Thus far, no mechanism-based account of respiratory modulated behavior has emerged. Recent theoretical proposals have suggested that these rhythms may alter behavior by shaping neural excitability and neural gain control, two interlinked mechanisms that control evidence accumulation processes. Other studies have found the coupling effect to be particularly dependent on the respiratory phase at which responses are made rather than phases at stimulus presentation, suggesting an effect on motor rather than perceptual processes.

Stimuli calibrated to each participant

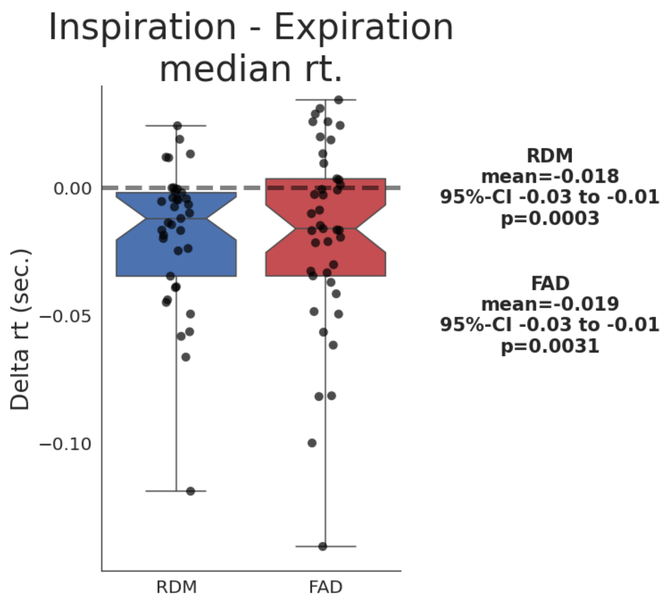


Trials grouped based on the time of stimulus onset and response respectively



Results

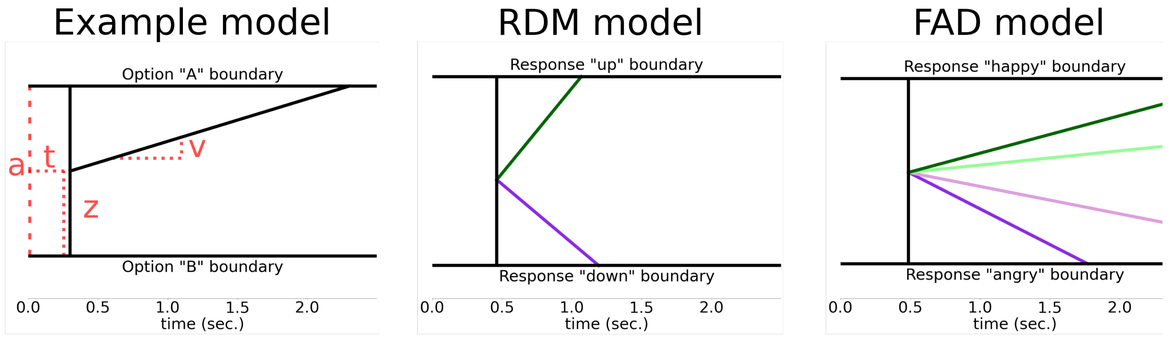
Binary comparison



- **Cross-modal decrease in median reaction time** during inspiration compared to expiration, based on **response grouping**.
- Paired t-tests showed no evidence for a difference in behavioral variables between inspiration and expiration for stimulus grouping.

Computational Modelling of Respiratory-Coupled Perception

Hierarchical Drift Diffusion Model



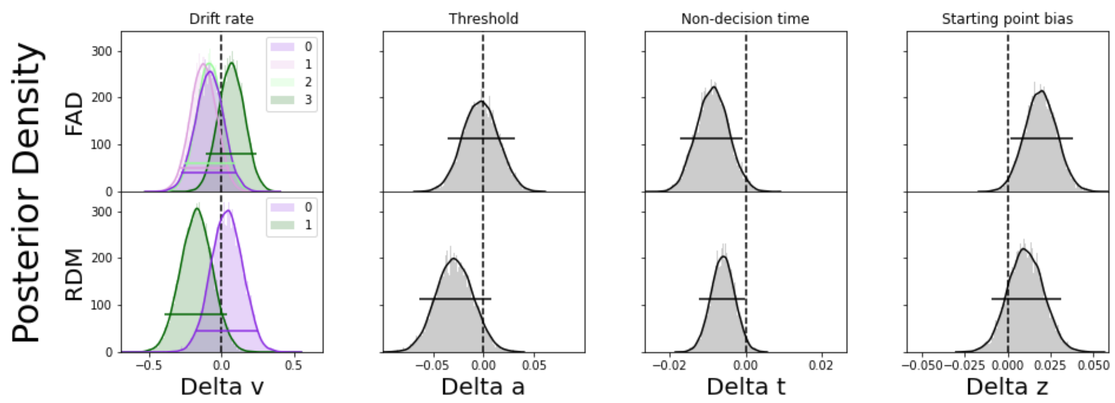
Parameter	Interpretation
Drift rate (*v*)	Quality of evidence acumulation
Boundary reparation (*a*)	Speed accuracy trade-off
Non-decision time (*t*)	Early perceptual proscesses and motor prep. and excexusion
Starting point bias (*z*)	Stimulus independend bias
Meta parameters (*sx*)	Inter trial variability of base parameters

Respiration modulates non-decision time

Model Comparison

Model	Breath Dependent	DIC	
		RDM	FAD
Full	*v,a,t,z,sv*	4024	11474
Hypo	*v,t,sv*	4027	11489
Null	-	4034	11486

Parameter Tests



Based on the literature, **we Hypothesized that *v, sv,* and *t* depend on respiratory phase**. We compared our hypothesized model to a full model where all basic parameters and *sv* could vary based on respiratory phase. Finally, we fitted a null model that did not depend on respiratory phase. For both tasks, the full model showed the best balance between fit and complexity and **suggested a shorter non-decision time for responses made during inspiration compared to expiration**.

Conclusion

- This is the first computational investigation of the effect of respiratory phase on perceptual decision-making.
- Our findings support the hypothesis of a cross-modal effect driven by coupling between respiration and the motor system.
- We will apply human neuroimaging (MEG) to investigate the neural mechanisms underlying the respiratory phase effect on decision-making.

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