Attributing Minds to Triangles: Kinematics are Key for the Correct Attribution of Mental States in the Animations Task

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BACKGROUND

- Humans readily attribute animacy to, and infer mental states from, movements of 2D geometric shapes (1)
- Previous studies have found interindividual differences in performance in these Heider-Simmel style tasks: Control participants have difficulties interpreting animations created by autistic individuals (2)
- These difficulties may be due to atypical movement kinematics in autistic participants: animations created by individuals with ASD exhibited higher jerk (2)
- No studies to date have tested whether jerk is directly related to accuracy in the animations task, and which other factors contribute to performance
- We investigated whether jerk, the shape trajectories of the triangles' movements and various other potential predictors are important for mental state attribution

METHOD

Stimulus Development

- 51 participants created 45 sec. long animations of 5 target words by moving 2 triangles on a touch-screen device
- Target words: **mocking**, **seducing**, **surprising**, **following** and **fighting**
- The final stimulus set contained 202 animations (~ 40 for each word)

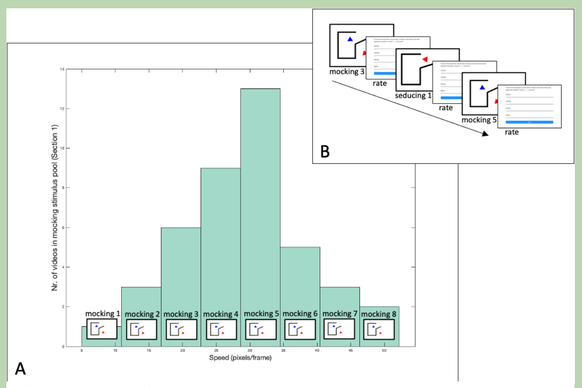


Figure 1: (A) Stimulus selection method (example mocking), (B) Example of stimulus presentation

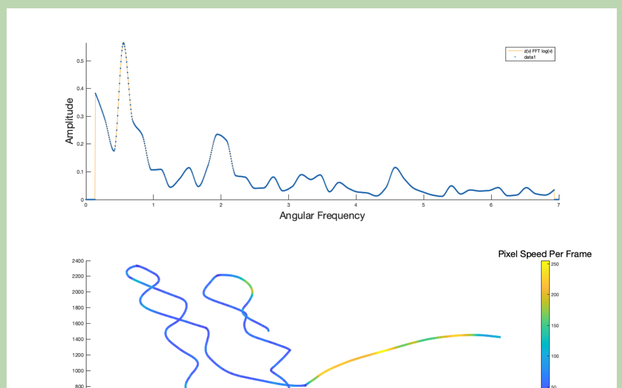


Figure 2: Angular frequency spectrum and related trajectory path

Ratings collection

- 37 naïve observers viewed 8 animations of each target word
- The 8 animations were selected such that the triangles' mean speed represented the speed frequency distribution of the stimulus pool (Fig. 1)
- After viewing each animation, participants rated the extent to which they perceived the video to display the target word

Analyses

- Accuracy was calculated as: **rating target word – mean (ratings non-target words)**
- Jerk (indexing change in acceleration), simultaneous movement, relative distance and mean rotation were entered in a **mixed effects model** predicting accuracy
- Following a method by Huh & Sejnowski (2015), **Angular frequency energy** was calculated as an additional predictor from the triangles' speed oscillations, capturing speed as a function of curvature (Fig. 2).

RESULTS

1) A one-way ANOVA showed that mean accuracy was different across word categories (Fig. 3)

2) Bootstrapped F-tests comparing angular frequency energy across all 5 word categories revealed 8 clusters of difference (Fig. 4)

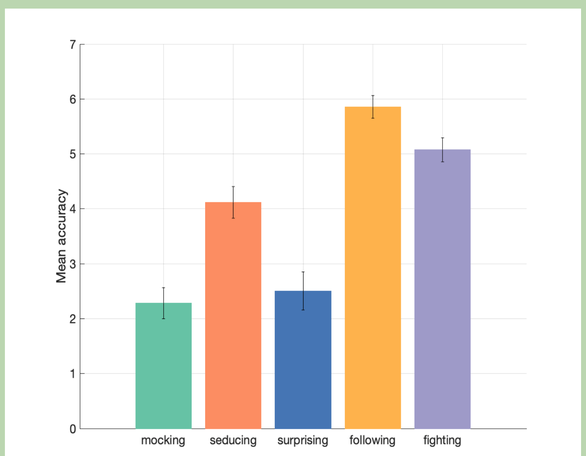


Figure 3: Accuracy across words

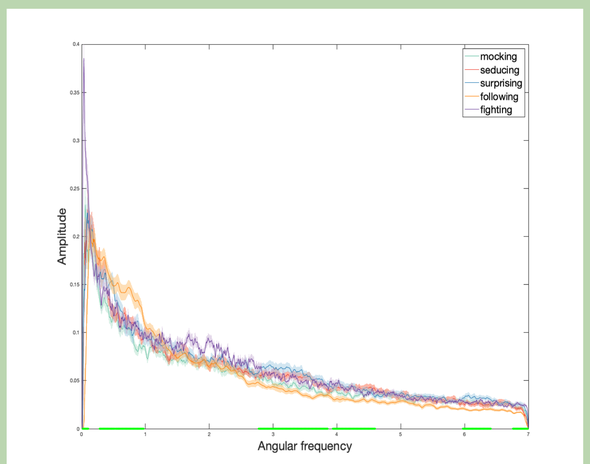
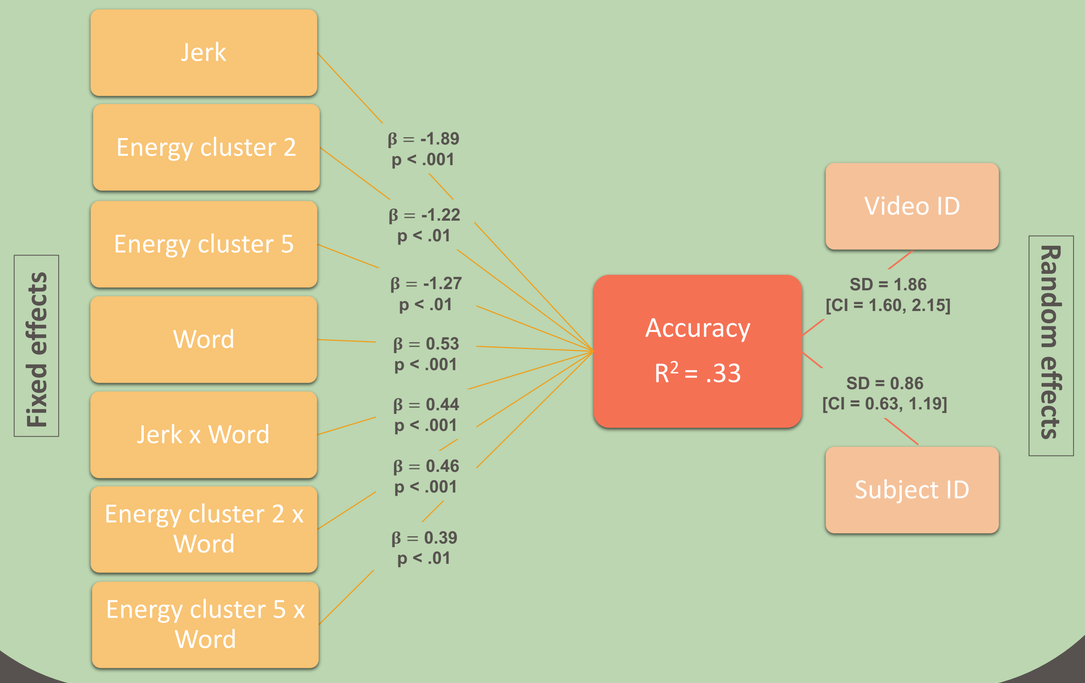


Figure 4: Clusters of difference in angular frequency

3) A mixed effects model revealed that Jerk and Angular Frequency Energy in 2 clusters predict accuracy but interact with word category:



CONCLUSION

- **Mean jerk** was the main predictor of accuracy in the animations task
- In addition, **2 clusters of angular frequency energy** significantly predicted accuracy
- Angular frequency energy values can be interpreted as a measure of **speed modulated as a function of curvature**
- There was a **significant interaction** between each predictor and word category, indicating that relationships between predictors and accuracy depended on the animation type
- The results suggest that both jerk (**overall change in acceleration**) and angular frequency energy (**change in speed as a function of curves drawn**) are important for successful mental state attribution in the animations task

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