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# Intelligence test solving through eye-movements and mouse-movements

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## Raven's Advanced Progressives Matrices

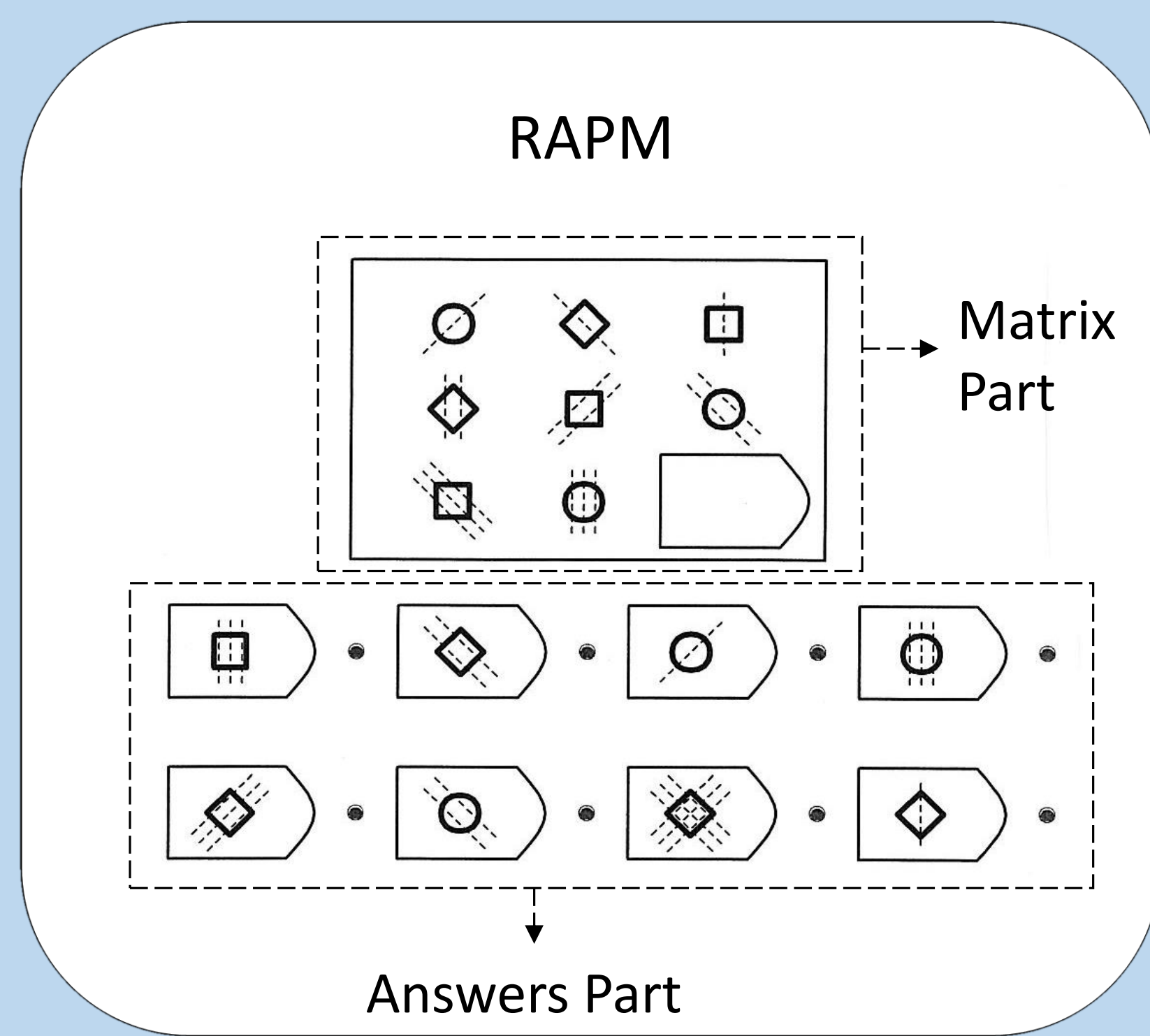
Raven's Advanced Progressives Matrices (RAPM) are common non-verbal psychometric tests used for assess reasoning and fluid intelligence.

### Two strategies :

- constructive matching : infere rules and construct a supposed answer, then finding the constructed answer among the proposed responses
- response elimination : Matrix and response features comparison in way of eliminating incorrect answers

### Correlation between strategies and performance (Carpenter *et al.*, 1990) :

- constructive matching strategie is associated with better score.
- response elimination strategies is associated with lower score.



## Previous Results

- Exploration-related **eye movement** indices reflecting strategies correlate with score<sup>1</sup>
- Exploration-related **mouse movement** indices reflecting strategies correlate with score<sup>2</sup>

Indices	Eye Tracking <sup>1</sup> (n = 55)	Mouse Tracking <sup>2</sup> (n = 130)
Item latency	0.03	0.63 ***
Time on Matrix	0.08	0.65 ***
Time on alternatives	-0.25	0.29 ***
Proportional Time on Matrix	0.48 **	0.56 ***
Proportional Time on alternatives	-0.44 **	-0.56 ***
Number of toggles	-0.27 *	0.02
Rate of toggling	-0.43 **	-0.55 ***
Latency to First Toggle	0.41 **	0.70 ***
Proportional Latency to First Toggle	-----	0.32 ***

Correlations between score and exploration-related indices

Although mouse movements add a supplementary cost to switching between elements, the change from eye movements to mouse movements preserves most correlations

<sup>1</sup> From Vigneau *et al.* (2006)

<sup>2</sup> From Rivollier *et al.* (in prep.)

## Present study

For this study, we have recruited 85 students for pass 12-items short form of RAPM. Each participant passed the test under one of the four dynamic interfaces. Mouse- and eye-movement were recorded.

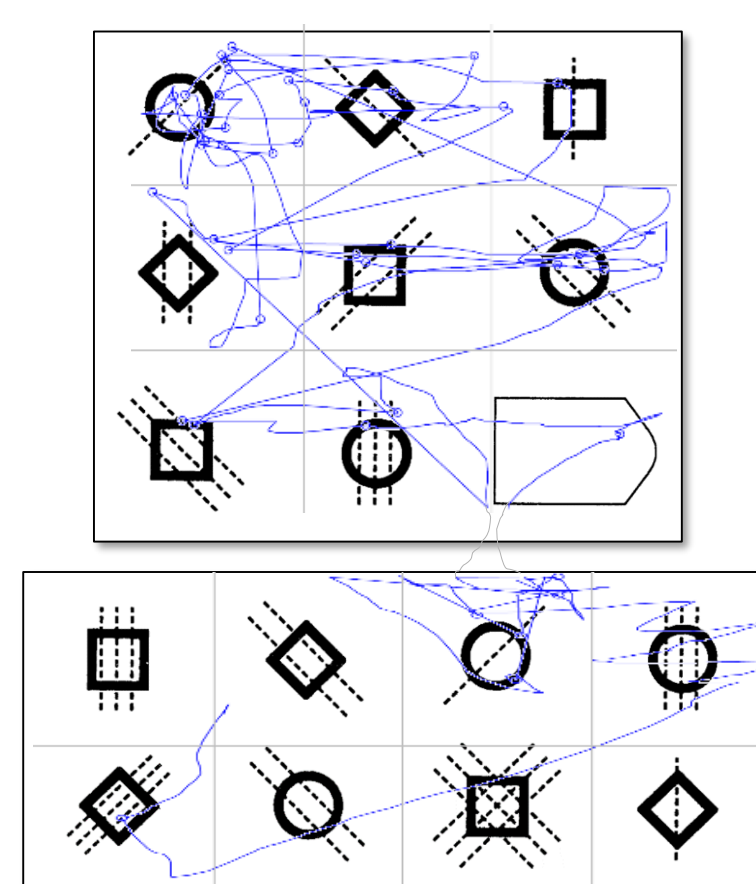
### Aims :

- Better understanding of the impact of visual constraints on solving strategies
- Coupling eye tracking and mouse tracking
- Investigate how visual and motor information-selection process coordinate

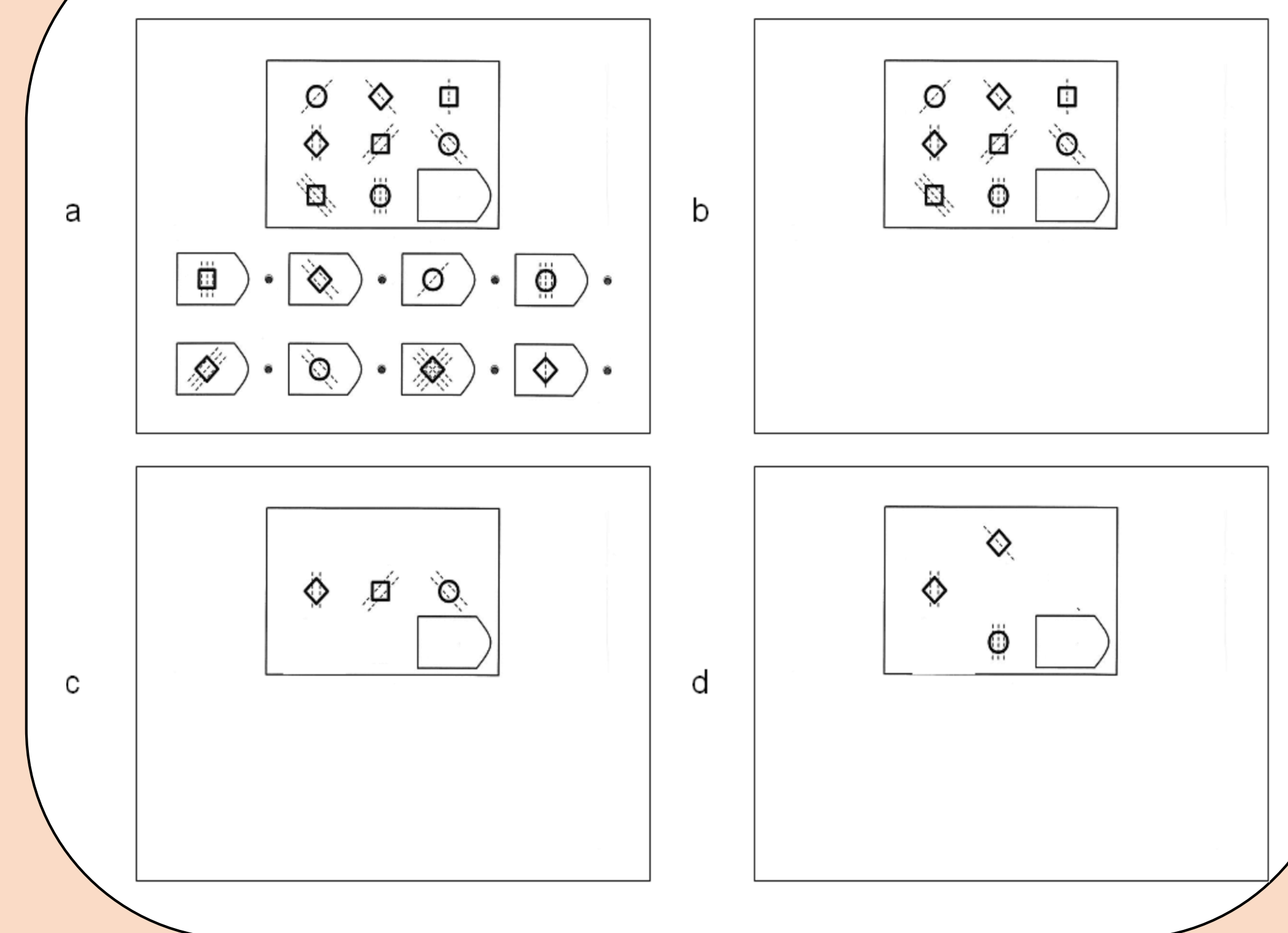
### Design :

- Four conditions for the interactions (between-subjet factor) :
  - Original** : full matrix and full answers parts visible all the time
  - Switch** : full matrix or full answers parts visible by clicking on it
  - Line** : one single line of the matrix or full answers part visible by clicking on it
  - Sequence** : upto three cells of the matrix or full answers part visible by clicking on it

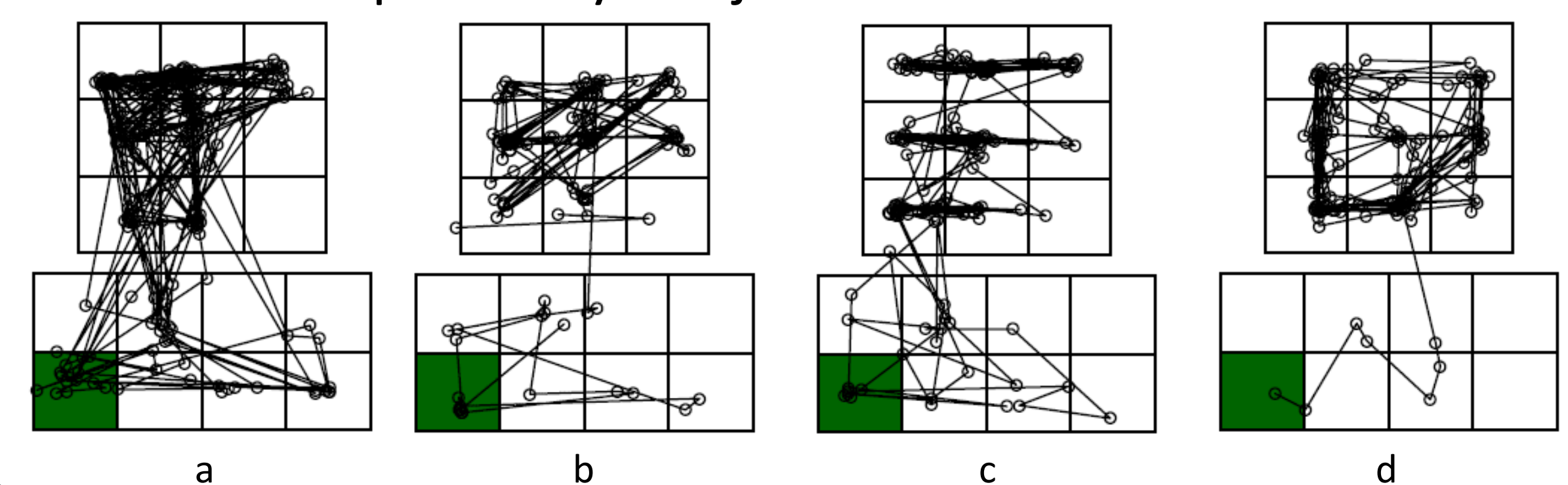
### Example of mouse trajectory



### Dynamic Interfaces



### Examples of eye trajectories for each condition



## Planned Analyses

- Similarity between mouse- and eye-exploration sequences (Dynamic Time Warping, Cross-correlation)
- Similarities of indices between interfaces
- Similarities of indices between manual- vs eye-measures

## References & Contact

Carpenter, P. A., Just, M. A., & Shell, P. (1990). What one intelligence test measures: A theoretical account of the processing in the Raven Progressive Matrices Test. *Psychological Review*, 97(3), 404–431.

Vigneau, F., Caissie, A. F., & Bors, D. A. (2006). Eye-movement analysis demonstrates strategic influences on intelligence. *Intelligence*, 34(3), 261–272.

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