Neural Correlates Underlying Active and Passive Abstract Rule Inferencing

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Introduction

- Whereas active inference uses hypothesis-driven actions to modify beliefs, passive inference uses only observations [1][2].
- Neural correlates of these distinct belief updating strategies are unclear.
- We applied a rule-learning task fMRI experiment to investigate neural responses underlying the engagement of active relative to passive rule inference approaches.

Methods and Materials

- Participants: 20 young adults (23.9 ± 2.74 yrs, 7 females)
- 6 EPI runs: TR = 1.48s, 36 axial slices, 64 x 64 matrix, 4 x 4 x 4 (mm)
- **Rule Learning Task:** Learn cue-category association rules using as few cues as possible.
  - **Active condition:** Choose which cues to receive.
  - **Passive condition:** Limited to predetermined cues in sequence.
- **Task Procedure**

The cues of the same rule will accumulate around the screen over time according to the actual correct answer to facilitate information processing.

Example of a rule:
The cue-categorization answer is exactly the same as the color of the "top" circle.

Example of another rule:
The answer is determined by the number of colors there are on the 3 circles.

Similar Behavioral Performances Across Active vs Passive

Different Neural Involvement During Cue Processing

- PASSIVE $_{Choose - Observe}$ > ACTIVE $_{Choose - Observe}$
- ACTIVE $_{Choose - Observe}$ > PASSIVE $_{Choose - Observe}$

$p < 0.001, k > 102$ $p < 0.001, k > 99$

R Fusiform gyrus (39, -49, -25)

L Postcentral gyrus (-45, -25, 56)

L Angular gyrus (-51, -67, 26)

Different Neural Involvement During Answer Selection

- ACTIVE $_{Ans - Choose}$ > PASSIVE $_{Ans - Choose}$

$p < 0.001, k > 103$

R Fusiform gyrus (30, -43, -22)

L Rolandic operculum (-45, -25, 23)

L Putamen (-27, -4, -1)

Conclusion

- Despite similar behavioral accuracy, distinct neural processes were engaged for active and passive inferencing.
- Active inference differentially suppressed angular gyrus cue responses and enhanced putamen responses for prediction selection, implicating internal modeling and action evaluation processes.
- Passive inference showed more perceptual-motor cue processing with lower responses for final rule prediction, suggesting less action evaluation.
- Our findings identify neural systems involved in processing hypothesis-driven actions.

References

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