

Development of action representation during adolescence

Suparna Choudhury¹, Tony Charman¹, Victoria Bird¹ & Sarah-Jayne Blakemore²

¹Behavioural and Brain Sciences Unit, UCL Institute of Child Health & ²Institute of Cognitive Neuroscience, University College London



Introduction

Action representation

- Internal models in the brain enable successful planning and execution of movement, by making predictions about actions.
- Motor imagery activates internal models of action.
- Mental chronometry taps internal models. Timing of real and imagined actions is highly correlated in typical adults.
- Lesion studies suggest involvement of parietal cortex in motor imagery.

Adolescent development

- During adolescence, body is subject to physical changes, including increase in limb size.
- Body kinematics change during adolescence – internal models need updating.

Hypothesis

If internal models are refined during adolescence, the correspondence between timing of real and imagined actions will increase with age.

Method

2 age groups:

- 40 adolescents (24 males; mean age 13.1 years)
- 33 adults (15 males; mean age 27.5 years)

All right handed

Children's version of the Florida Praxis Imagery Questionnaire was used to check ability to form motor images

Time to execute and imagine actions was measured on two tasks:

- (1) Triple 8 task
- (2) Fingers task

Method continued

Task (1) Triple 8

Executed (E) blocks: When experimenter said "Go", participants drew three consecutive figure 8s as fast and as accurately as they could within the lines (Figure 1).

Three different sizes of figure 8 used: 70, 35, 18 mm high.

Imagined (I) blocks: When experimenter said "Go", participants imagined the equivalent actions and said "stop" out loud when finished.

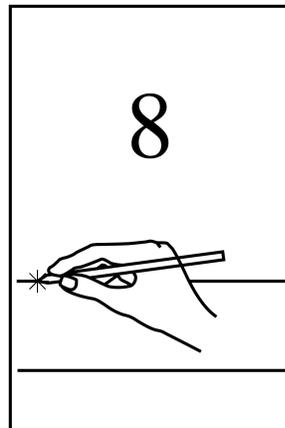


Fig. 1

Task (2) Fingers

Executed (E) blocks: When experimenter said "Go", participants touched their right thumb to the tip of the little finger and then to the tip of the index finger (Fig. 2) repeating five times, as a continuous sequence. Left and right hand were used in alternate blocks.

Imagined (I) blocks: When experimenter said "Go", participants imagined the equivalent actions and said "stop" out loud when finished.

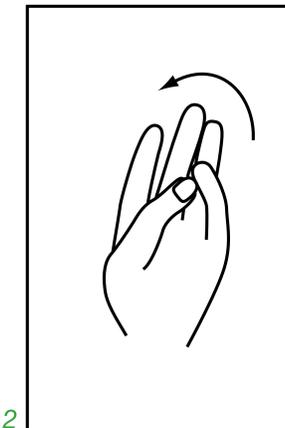


Fig. 2

Correlation between Executed (E) and Imagined (I) across individuals was recorded for each task and compared between age groups.

Results

(1) Triple 8 task

Triple 8 task: increase in I-E correlation between adolescence and adulthood (Fig. 3)

- Significant correlation between E and I for both age groups ($R^2(\text{adolescents})=0.58$; $R^2(\text{adults})=0.97$; $p<.01$ for both).
- Correlation between E and I significantly higher in adults than adolescents ($Z=2.61$; $p<0.01$)

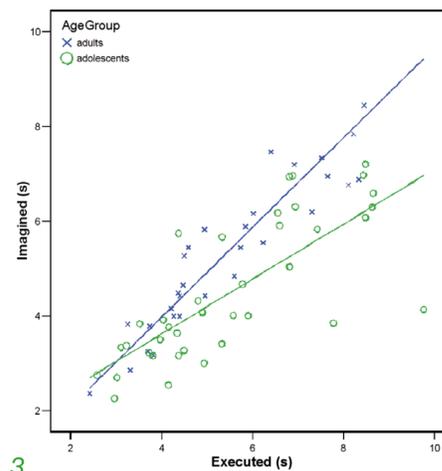


Fig. 3

(2) Fingers task

Fingers task: increase in I-E correlation between adolescence and adulthood (Fig. 5)

- Significant correlation between E and I for both age groups ($R^2(\text{adolescents})=0.82$, $R^2(\text{adults})=0.96$; $p<.01$ for both).
- Correlation between E and I significantly higher in adults than adolescents ($Z=3.20$; $p<0.01$)

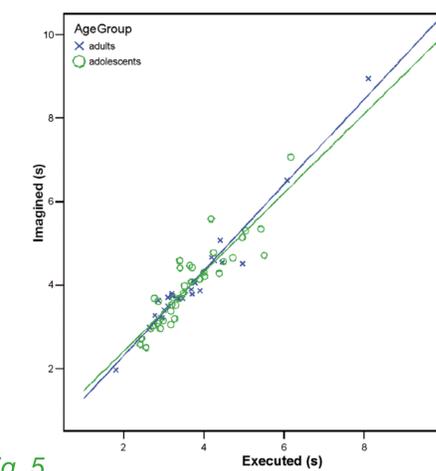


Fig. 5

Triple 8 task: no change in E or I with age (Fig. 4)

- No significant correlation between age and movement execution time (E) ($R^2=2.9 \times 10^{-4}$; $p=0.89$) nor between age and imagery time (I) ($R^2=0.044$; $p=0.082$).

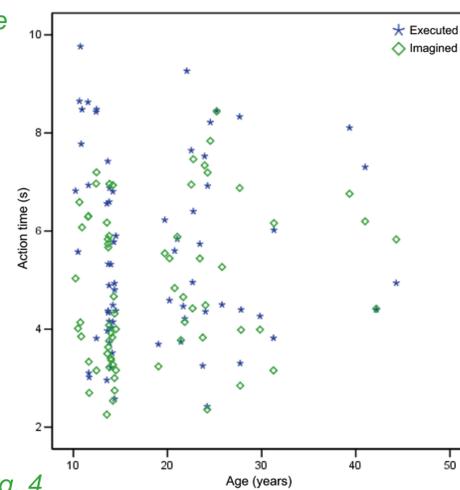


Fig. 4

Fingers task: no change in E or I with age (Fig. 6)

- No significant correlation between age and movement execution time (E) for the ($R^2=0.041$; $p=0.1$) nor between age and imagery time (I) ($R^2=0.042$; $p=0.1$).
- No laterality effect.
- No gender effect for either task.

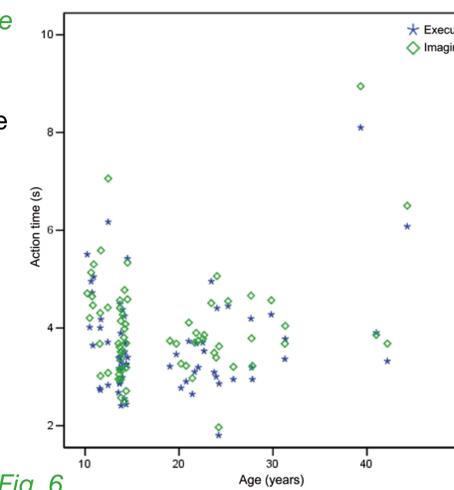


Fig. 6

Discussion

Specific refinement of motor imagery between adolescence and adulthood

- Highly significant correlation between E and I in both age groups suggests ability to represent actions is in place by adolescence.
- Significant increase in I-E correlation suggests internal models are refined during adolescence.

Development of the adolescent brain

- Histological and structural MRI data have shown major cortical development during adolescence.
- One of the areas that develop most is parietal cortex. Internal models have been linked with parietal cortex.
- Development of parietal cortex may support development of internal models in relation to developing body.

Questions

- What are the differential roles of cortical networks in development of internal models?
- How does development of action representation relate to development of social cognition?

References

- Decety, J. et al. (1989). The timing of mentally represented actions. *Behav. Brain Res.* 34, 35-42.
- Gogtay N. et al. (2004) Dynamic mapping of human cortical development during childhood through early adulthood. *PNAS, USA.* 101, 8174-9
- Jeannerod, M. (1997). *The Cognitive Neuroscience of Action.* Oxford: Blackwell
- Sirigu, A. et al. (1996). The mental representation of hand movements after parietal cortex damage. *Science*, 273, 1564-1567
- Wilson, P. et al. (2001). Abnormalities of motor and praxis imagery in children with DCD. *Human Movement Sci.* 20, 135-159

Developmental change was specific to motor imagery and not a consequence of general cognitive-motor improvement