The nature of the training effects of mental rotation: the limit for transfer to novel orientation

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INTRODUCTION

Repeating mentally rotating a figure increases the speed of mental rotation of the figure (Bethell-fox & Shepard, 1988). Although there are some studies about what causes the training effects (e.g., Wallace and Hofelich, 1992; Tarr and Pinker, 1989; Heil et. al., 1998), the underlying mechanisms remain unclear.

We investigated whether the training effects of mental rotation transfer to un-trained orientation and un-trained direction. If the training effects depend on the orientation of the figure, it is suggested that the training improves retrieving the representation of the figure in respective orientation. If the direction dependent training effects are observed, it is suggested that the training improves rotation process.

METHOD

Participants

35 (14 females) students aged 19-24 years old (mean age was 21.9 years old) were participated. They had normal or corrected-to-normal vision.

Stimulus

2 sets of 2D polygons were used. Each set has 4 polygons. One set was used for training, and the other was used for test. The assignment of the figure sets was counterbalanced across the participants.

Tasks

Participants performed the mirror-normal discrimination task. They pressed the left-arrow key when they saw normal figure and pressed the right-arrow key when they saw mirror-reversed figure, as quickly and accurately as possible.

RESULTS AND DISCUSSION

About Orientation

The slopes and the intercepts showed a significant main effect within the one factor ANOVA (3 levels; Training 6, Old dir (new ori) and Old dir(novel ori) ) [slope: F(1,29)=36.850, p<.001, intercept: F(1,29)=10.277, p<.01].

Multiple comparisons revealed significant differences for slopes and intercepts (see figure). The slope for Old dir(novel ori) condition was larger than that for Training 6 and Old dir(new ori). This suggests that the training effects well transfer to the orientation covered in the training and poorly transfer to the orientation not covered. Since intercept is considered to reflect encoding for preparing rotation for each figures, it is suggested that encoding process was continuously improving in the test phase.

About Direction

There is no significant difference between Old dir(novel ori) and New dir(novel ori) nor between Old dir(new fig) and New dir(new fig). This means that the training effects do not depend on the direction.

CONCLUSION

We investigated the transfer of the training effects of mental rotation to un-trained orientation and un-trained direction. Results were that the training effects transfer to the new orientation of the trained figure, but not to the novel orientation. They also transfer to un-trained direction of rotation. This suggests that the training of mentally rotating improves the retrieving process of the figures and not rotating process.