Mental Rotation Transfer

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The mechanisms underlying the effects of practice on mental rotation are still incompletely understood. Explanations that may apply include improved rotation processes (Wallace & Hofelich, 1992) and the learning of figure exemplars (Tarr & Pinker, 1989). One comparison of these two theories supported an exemplar explanation: Heil, Roesler, Link and Bajric (1998) looked for transfer of mental rotation performance in three conditions where 3-D block figure stimuli pairs were either identical to practiced pairs, the same objects around mixed old and new axes, or new objects around mixed axes. They found that mental rotation skill only transferred to the identical condition.

In contrast to this, in an experiment that included less practice and a transfer condition in which only the figure views were different, we found transfer of rotation performance.

There were two parts to the experiment. Participants trained for five blocks of 32 trials each, following which they tested in one mixed block for 128 trials. The four stimuli figures were identical to Shepard and Metzler (1971) and presented in pairs at four angular disparities: 0°, 40°, 80°, or 120°. Presentation was randomized and one-half of the trials were unanalyzed mirror-image foils.

Of the 128 test trials, 32 were identical to training, 32 involved the same axis of rotation but substantially new views on the same stimuli (at least a 90 degree oblique rotation), 32 involved the same view on the stimuli but an orthogonal axis of rotation (in this case the stimuli from the same/ same condition were simply presented rotated 90° around the Z), and 32 involved both an orthogonal axis of rotation and new views on the stimuli. This design allowed for a two by two (same vs different figures, same versus different axes) within-subjects comparison. Four between-subjects conditions of the experiment were run to counterbalance for possible effects of the stimuli set or the trained axis of rotation. Results for these counterbalanced conditions were not significantly different and were aggregated. 47 undergraduates participated of which 9 were discarded for failing to meet criterion performance.

Average millisecond per degree rotation speeds for each of the training blocks were calculated based on the assumption of a linear relationship of rotation latency and angular disparity. There were significant indications of learning indicating that participant RS's improved over training. In transfer participants showed a significant advantage to rotation around the same axis as training that did not depend on whether the figure views were the same or new. Mean times to judge 0° rotation pairs (intercept times) were significantly faster in the same-same condition than in any of the other conditions. See Table 1.

Table 1: Data Summary

	Train Blk. 1	Same/ Same	Same/ Orth.	New/ Same	New/ Orth.
Mean RS (ms/°)	18.8	15.2	16.3	13.3	17.2
0° (ms)	1830.5	1134.9	1345.3	1350.4	1327.7
40° (ms)	2800.5	1845.6	2242.7	2255.9	2345.4
80° (ms)	3314.3	2381.1	2949.4	2861.3	2972.4
120° (ms)	4164.7	2984.9	3280.8	2922.8	3410.6

Unlike the Heil, et al. (1998) study, our results suggest that transfer of rotation skill involving rotation around a particular axis can occur to new stimuli views. While we do not claim to refute Heil et al. (1998), it does seem that non-stimulus-specific transfer can occur. On the other hand the special advantage for 0° rotation pairs that were repeated from training does suggest that there is also a stimulus-specific component to the learning. The fact that the new view/same axis transfer condition showed transfer of RS, yet showed no benefit in the 0° disparity (identity recognition) trials suggests that our new view stimuli condition was significantly unique and transfer of rotation skill to these new views depended on general rotation learning independent of any exemplar view strengthening. As revealed by the data and a subsequently formulated ACT-R model, there is a complex variety of learning that is taking place in the first 200 trials of a mental rotation experiment.

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