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Can the Raven's Progressive Matrices Intelligence Test Be Solved by Thinking in Pictures?

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Grand Ballroom E Level 5 (Philadelphia Marriott Downtown)

9:45 AM
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Background: Both children and adults with autism spectrum disorders (ASD) often perform better on the Raven's Progressive Matrices intelligence test than on multi-domain intelligence tests like the Wechsler scales, whereas typically developing individuals do not show this pattern. Given the strong visual abilities of many individuals with ASD, one hypothesis explaining these data is that individuals with ASD can use visual strategies to solve the Raven's test, which consists entirely of visual analogy problems, but such visual strategies are successful only on the visual portions of broader tests like the Wechsler scales. In line with this hypothesis, a recent fMRI study showed that, relative to typically developing controls, a sample of individuals with ASD displayed increased neural activity in the extrastriate visual cortex and decreased activity in prefrontal and parietal regions while solving the Raven's test.

Objectives: Even though the Raven's test consists of visual problems, most information processing accounts assume that people solve it using verbal, rule-based strategies, and behavioral evidence from typically developing individuals supports this view. However, this study aims to examine, from an information processing perspective, whether visual strategies can also be used to successfully solve the Raven's test. A positive result will 1) show that the hypothesis of certain individuals with ASD solving the Raven's test visually is computationally feasible, and 2) provide a computational basis for making behavioral predictions to further test this hypothesis.

Methods: Two computational models were developed that try to solve problems from the Raven's test using visual strategies. In contrast to existing computational accounts that require the translation of visual (i.e. pixel-based) representations of Raven's problems into propositional (i.e. verbal-symbolic) descriptions, both visual models operate directly on the given visual inputs from the test. The first model uses affine transformations to predict the answer for a given problem, and the second model automatically converts each problem into fractal image representations and chooses the best-fit answer based on a measure of fractal similarity. Both of these models have been tested on portions of the Raven's Standard Progressive Matrices test and on similarly constructed visual analogy problems.

Results: Both the visual affine model and the visual fractal model have successfully solved significant numbers of Raven's (or similar) visual analogy problems. For example, the affine method correctly answers about 60% of the problems on Set B from the Raven's Standard Progressive Matrices test, and the fractal method correctly answers about 70% of these problems.

Conclusions: Two different computational models can successfully solve many problems from the Raven's Progressive Matrices intelligence test using visual strategies. These results offer a new information processing basis for the hypothesis that, unlike typically developing individuals who use verbal strategies, certain individuals with ASD might solve the Raven's test visually. In further work, these models will be used to generate behavioral predictions to distinguish whether an individual is using visual as opposed to verbal strategies on Raven's-type problems.