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Effects of Statistical Training on Children with Autism Spectrum Disorder

Introduction:

This research looks at Autism Spectrum Disorder, or ASD, to see if a brief statistical training influences probabilistic reasoning skills in children with ASD. *Autism Spectrum Disorder (ASD)* is a neurodevelopmental disorder that affects many different parts of an individual's functioning. It is characterized by impairments in social functioning and language, such as communication and interaction skills. Individuals with ASD struggle with *generalization*, which is the ability to extract a general principle or rule based on small amounts of data. This skill is incredibly important when it comes to learning; in fact, much of how we learn about the world involves generalizing from the information around us. In order to make such generalizations it's necessary to have an understanding of *intuitive statistics*, which allows human learners to make predictions based on the data given.

Previous Research:

Sim & Xu (2016) explored this understanding of intuitive statistics, and found that that children with ASD show weaknesses in probabilistic reasoning as compared to typically developing (or TD) children. They conducted a study showing both TD children and children with ASD videos of objects bouncing around inside circles (Figure 1.1) of three yellow objects and one blue object.

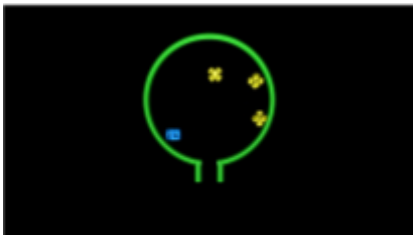

Figure 1.1 *Sim & Xu (2016)*

During the test trials, the circle would be blocked as well as the outcome, and the child would be shown two outcome cards (Figures 1.2 &1.3) and had to choose which one they think would happen; would the majority (yellow) object be the one that fell out, or the minority (blue) object?

Figure 1.2 *Outcome 1*

Figure 1.3 *Outcome 2*

The results of the study showed that children with ASD did show impairments in probabilistic reasoning, meaning they weren't able to correctly infer that the majority objects were more likely to fall out. This could allude to something very important about the underlying mechanisms of ASD being rooted in the way children with ASD learn new information, which would have cascading consequences in all domains of learning throughout their lives. This study leaves the need for exploration of ways in which children with ASD could acquire such skills of probabilistic reasoning.

Stanley & Lawson (2014) sought a similar goal, but with typically developing (TD) children. They found that an explicit training on statistical principles for TD children increased their ability to accurately use these skills.

Goals:

All of this led to the research question: *Would a statistical skills training influence probabilistic reasoning for children with ASD?* This project had a few goals in mind, a broad goal of testing for the most effective methods of intervention in improving upon these probabilistic reasoning skills in children with ASD, and the short-term goal of this specific study to begin with a training design that was as minimal as possible, providing a solid foundation for research.

Seeing as the Sim & Xu study revealed that children with ASD do show impairments in their probabilistic reasoning skills, and the Stanley & Lawson study showed that training was successful for their TD participants, similar procedural designs from these studies were used to create the procedure for this study.

Methods:

The procedure consisted of four main phases:

First, a *pre-test*, based on a similar design as the Sim & Xu study, consisting of multiple trials in which the child would be shown a box containing four balls (Figure 2.1), three of one type (i.e., basketballs) and one of another type (i.e., soccer ball). The experimenter would close their eyes and draw one of the balls out, and the action and outcome would be blocked from the child's view. The child would then be shown two outcomes and had to say which one they thought had happened; was it the majority object (i.e., basketball) or minority object (i.e., soccer ball) that had been drawn out?

Figure 2.1
Pre-Test Stimuli

Second, there was a brief training that involved three different boxes, each filled with different objects of different proportions (Figure 2.2). This training was designed to be a demonstration; the experimenter would close their eyes and draw one of the objects out. The boxes were rigged so that the experimenter would draw out the majority object each time. This training was meant to demonstrate to the child that the majority object is more likely to be drawn out than the minority object.

Figure 2.3
Post-Test Stimuli

Third, there was a post-test that was the same design as the pre-test (Figure 2.3), to test for a difference in performance after the training session versus before.

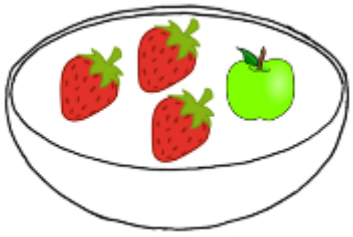

Figure 2.4
Transfer Task Stimuli

Fourth, there was a transfer task (Figure 2.4); again, this was the same design as the pre- and post-tests but with different objects. This was to further test the effects of the training, on a task that involved utilizing the same skill across a new context.

Results:

The results were tested using a one-way repeated measures ANOVA test, and the results were not statistically significant. The graph of results (Figure 3.1) shows that the training did not have a significant effect on children's scores.

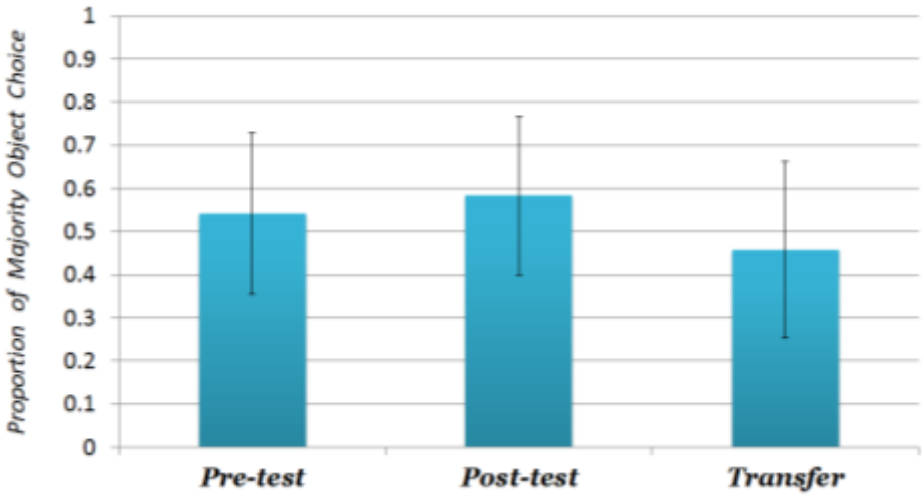

Figure 3.1 *Proportion of majority object choice for three test phases*

These results aren't altogether too surprising. As mentioned previously, the training was designed to be as minimal as possible, meaning no feedback or correction was given to the children. This was done to provide a base level understanding of training effects, so this research can start here and build up from it.

For children with ASD who do show difficulty in taking information and generalizing it to something else, taking this training demonstration and applying the skills to the tasks would be very difficult, and as the results show, an ineffective method of intervention.

Conclusion:

This study paves the path for important future research. Knowing now that a minimal, demonstration-styled training does not have a significant effect on improving probabilistic reasoning skills, the question remains to be explored: What types of trainings are effective? And how broad can the effects be?

Moving forward with the results from this research, the goal is to design an intervention that, like in Stanley & Lawson, provides feedback and correction, while also catering specifically to children with ASD. This could be more effective in helping children with ASD generalize the trained skills to different contexts. A long-term goal, if such an intervention is found effective, is: Can the skills be applied across contexts and time?

There is still so little known about ASD and how to effectively intervene with it, but this research can have far-reaching implications for ASD in our understanding of its underlying mechanisms and the ways we treat it.