Reasoning by exclusion: faces & voices, novel words and searching for objects

Justin Halberda

Department of Psychological and Brain Sciences

The Johns Hopkins University

3400 North Charles St.

Baltimore MD 21218

Learning by exclusion requires a child to use what they currently know in order to eliminate possibilities and to construct new knowledge. This type of learning need not be intentional and conscious (though such language is often used when describing it). A clear case of this learning is children’s use of process-of-elimination. Previous research demonstrates that preschoolers will rely on process-of-elimination (Disjunctive Syllogism) in order to determine the referent of a novel label (Halberda, 2006). When asked to, e.g., “point at the dax,” preschoolers systematically searched and rejected familiar object distractors (e.g., ball) before deciding to map the novel label “dax” to a novel object. What are the origins of these abilities? Is reasoning via process-of-elimination a domain general ability that preschoolers rely on in a variety of learning contexts or is it specific to word-learning? In this paper I present behavioral experiments including N=60 children ages 2.5 – 5 years. Children participated in a variety of games where they had to search for hidden objects, learn to match new voices with new faces, or learn novel nouns. In each case, children’s pointing and looking behavior was used as a measure of their mapping abilities and as an indication of their successful learning via process-of-elimination.

In each of 3 experiments, a standard preferential-looking procedure was used. Participants were seated at a table and presented with two or more objects on each trial. After a measure of baseline looking preference, participants were asked to find the target item. On critical test trials, the target item could be inferred via a process-of-elimination. For example, when pictures of two faces were presented – one person that the child knew and one novel person – and children (n=20) heard a novel voice speaking, they could infer that the new voice must belong to the new face because each person has only one voice (i.e., “that is not Charlie’s voice I’m hearing, so it must be this new person who is talking”). On critical trials for the novel noun task, a new group of children (n=20) were presented with a familiar object (e.g., ball) and a novel object and asked to “point at the dax.” Children could reason via process-of-elimination to infer that the new label must go with the novel object (i.e., “this object is called a ‘ball’ so that strange object there must be the ‘dax’.” And, on critical trials for the object search task, a new group of children (n=20) were presented with an opaque hiding box that they knew held a particular animal (e.g., bear) and a second opaque hiding box they had not seen before and they were asked to find an animal they hadn’t seen before (e.g., “can you find dog”). Children could reason via process-of-elimination to infer that the new animal (e.g., dog) must be in the new box (i.e., “the dog can’t be in this box because I know that bear is already in there and dog wouldn’t fit, so dog must be hiding in this new box”).

In each experiment, participants’ fixation times to both targets and distractors and their reaction times to change fixation were coded frame-by-frame from videotape. Both reaction time data and the course of looking throughout each trial revealed a pattern consistent with reasoning via process-of-elimination. When asked to e.g., “point at the dax,” participants systematically searched and rejected familiar object distractors before deciding to map the novel label “dax” to the novel object. Likewise for mapping faces to voices and finding hidden animals. Further, the pattern of looking in each task was parametrically similar suggesting that, for preschoolers, process-of-elimination is a domain general learning strategy.

Thoughts for summary statement:

- Children learn so much and start from so little. An enduring fascination with the success of this learning has driven many developmental scientists, educators and parents to consider how children accomplish it. A remarkable variety of cognitive, social, and perceptual mechanisms have been considered to be important – and given the deep complexities posed by any learning, perhaps all of these mechanisms are required and used by the child. Children appear to take what they know and build from it new and richer knowledge.

The fundamental challenge posed by learning – i.e., using what one knows in order to learn something new – is highlighted quite starkly in cases where children may reason via exclusion. …

- Cognitive strategies grounded in both symbolic and associative computations may help guide learning across the lifespan.

- (Given that they want us to highlight multiple approaches, it might be a good thing to highlight the multiple content domains we will touch on (even if we are all using behavioural studies) and maybe also that our discussion will debate the various computational approaches to characterizing this learning (e.g., Bayesian, associative, symbolic).