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Brief Report

Social learning promotes understanding of the physical world: Preschool children's imitation of weight sorting

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ABSTRACT

We investigated whether social learning, specifically imitation, can advance preschoolers' understanding of weight. Preschoolers were randomly assigned to experimental and control groups. The experimental group saw an adult intentionally categorize an array of four visually identical objects based on weight. Then, children's weight-based sorting of the objects was evaluated. To test generalization, children were presented with novel objects (differing in shape, color, and weight from the original ones) and not shown what to do with them. Results indicate that 48-month-olds learned to sort by weight via observing the adult's demonstration of categorization and that children generalized weight sorting to novel objects. This shows that children imitate at a more abstract level than merely motor actions. They learn and imitate generalizable rules. 36-month-olds did not succeed on this weight sorting task. Children's cognitive development constrains what children learn through social observation and imitation.

Introduction

Object weight pervades our everyday cognition and scientific thinking. Balance and digital scales make this property public, shareable, and precise. Because weight cannot be seen, how humans come

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to understand the concept of weight poses an interesting developmental problem (Smith, Carey, & Wiser, 1985). We hypothesize that social learning plays a role. The current study addresses three interrelated issues: (a) how children can learn about invisible object properties, (b) children's ability to use imitation to acquire abstract rules, and (c) the interaction of cognition and social learning during early childhood.

Piaget reported that young children exhibit little or no understanding of weight at a conceptual level—only at the physical level of exerting different forces to manipulate objects of various weights (Inhelder & Piaget, 1958; Piaget, 1952). Subsequent investigations suggest earlier competencies. For example, 3- and 5-year-olds predict object weight based on size (Gordon, Forssberg, Johansson, Eliasson, & Westling, 1992) and begin to choose heavy versus light objects to tip scales in rule-governed ways (Siegler, 1976). At a more primitive level, studies report that infants can perceive and learn about differences in object weight (Mash, 2007; Molina & Jouen, 2003; Mounoud & Bower, 1974). They can use object appearances (e.g., color, material) to guide their actions with differently weighted objects (Hauf, Paulus, & Baillargeon, 2012; Paulus & Hauf, 2011). Moreover, infants adjust their reaches based on how much the object compresses a soft support structure, presumably revealing its weight (Hauf et al., 2012), and neuroscience studies using electroencephalography (EEG) show that infants use their own self-experience with heavier versus lighter objects to form expectations about the actions of another person lifting those same objects (Marshall, Saby, & Meltzoff, 2013).

One key development during the preschool years is learning to consider weight independently from visual appearance. Between 3 and 4 years of age, children improve in reporting that two visually identical objects have different weights (Smith et al., 1985) and in choosing the heavier of two visually identical objects to make a balance tip (Schrauf, Call, & Pauen, 2011). After receiving explicit verbal instruction and feedback, preschoolers will also sort visually identical objects based on a weight difference (Povinelli, 2012). In this latter work, children handled pairs of objects, saw where to place each depending on its weight, and received explicit rewards for correct placements. When subsequently tested, 3- to 5-year-olds showed high performance when sorting the same objects, which transferred to objects that varied in color from the original pair. In a further test, an apparatus forced children to decide where to place an object (based on a learned visual cue to its weight) before hefting the specific object. Only at 5 years of age did children show above-chance sorting performance without tactile experience of the weight. Thus, previous research indicates that with explicit training preschoolers can group objects by weight, especially in conjunction with first-person kinesthetic experience.

Another possible way children may learn about weight is through observing others' interactions with objects of different weights. Research shows an increasing scope to imitation during the preschool years (e.g., Herrmann, Legare, Harris, & Whitehouse, 2013; McGuigan, Whiten, Flynn, & Horner, 2007; Meltzoff & Williamson, 2013). In the social realm this includes conventions and rituals (e.g., Herrmann et al., 2013), and in the physical realm it includes instrumental knowledge about object properties and functions (e.g., Cladiere & Whiten, 2012). Several studies indicate that children's imitation is not limited to reproducing specific motor acts. Children infer and imitate the intended goal of a series of unsuccessful behaviors (e.g., Meltzoff, 1995). For example, 18-month-olds who saw an adult repeatedly try but fail to pull apart a dumbbell-shaped toy were as likely to produce the goal of pulling the object apart as were those who saw the adult successfully complete the act. Children will also disregard inefficient acts in favor of reaching a goal using their own means (which has been called "emulation"; Nagell, Olguin, & Tomasello, 1993). Related research has used imitation to study causal understanding (Horner & Whiten, 2005; Meltzoff, Waismeyer, & Gopnik, 2012; Schulz, Hooppell, & Jenkins, 2008). After observing a sequence that includes an ineffective action and an effective action, 3-year-olds often reproduce the causally efficient action but omit the unnecessary act (Want & Harris, 2001; Williamson & Meltzoff, 2011). In addition, 3-year-olds are more likely to use an emulative strategy to retrieve a reward from a puzzle box than are 5-year-olds (McGuigan et al., 2007).

Research also provides evidence of preschoolers extracting more abstract information, such as rules and strategies, from observing others' behavior, which is a crucial foundation for cultural learning. Three prominent examples have emerged.

First, Subiaul and colleagues described "cognitive imitation," in which children reproduce an observed sequence rule (Subiaul, Romansky, et al., 2007; Subiaul, Lurie, et al., 2007). Preschoolers who saw an adult press pictures on a screen in a particular order needed fewer trials to learn the