Journal of Experimental Child Psychology 162 (2017) 268–281

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Young children's attributions of causal power to novel invisible entities

Jonathan D. Lane [a,*], Patrick Shafto [b]

[a] Vanderbilt University, Nashville, TN 37203, USA
[b] Rutgers University–Newark, Newark, NJ 07102, USA

ARTICLE INFO

Article history:
Received 21 March 2017
Revised 28 May 2017
Available online 22 June 2017

Keywords:
Causal inference
Invisible entities
Conceptual development

ABSTRACT

In two studies, we investigated the development of children's reasoning about potent invisible entities. In Study 1, children aged 2.2–5.5 years ($N = 48$) were briefly told about a novel invisible substance that could produce a novel outcome—make a novel box turn green. During this introduction, children watched as one container was inverted over a box and the box lit up green, and then another identical container was inverted over the box and the box did not light up. On test trials, the experimenter inserted a spoon in novel (actually empty) containers and inverted the spoon over the box, which turned green in one trial and did not light up in the other trial. For both trials, children were asked whether there was anything in each container. Children across this age range appropriately reported that an invisible substance was present only when the box lit up. In Study 2, children aged 2.4–4.5 years ($N = 48$) watched similar demonstrations but were not explicitly provided information about the invisible substance. Children as young as 3 years spontaneously inferred that an invisible substance was present when the box lit up and was absent when the box did not light up. A final task tested children's ability to use their causal knowledge of invisible substances to *produce* an effect—making the box light up. The youngest children had difficulty with this task, but many children aged 3.5–4.5 years performed capably. These results indicate an early-emerging understanding of potent invisible entities that develops rapidly during early childhood.

* Corresponding author.
E-mail address: jonathan.lane@vanderbilt.edu (J.D. Lane).

http://dx.doi.org/10.1016/j.jecp.2017.05.015
0022-0965/

Introduction

Learning is often viewed as a process of updating beliefs in response to observed data. Causal learning is arguably the canonical case; from patterns of observed temporal co-occurrence, we must infer the presence of an unobservable power that links one event to a subsequent event (Hume, 1888/1978; Michotte, 1963). However, there are many instances of unobservable but causally potent entities—chemicals, germs, essences, beliefs, atoms, gods, souls, and Chi—that play central roles in how we explain observable events. In these cases, the causal entities are themselves invisible and temporal co-occurrence is not always observable. So, the inference problem might be more challenging. The world over, children are taught and hear about an array of such causal entities (Bering, 2006; Guerrero, Enesco, & Harris, 2010; Harris & Koenig, 2006; Harris, Pasquini, Duke, Asscher, & Pons, 2006; Lane & Harris, 2014) and have rich concepts of many of them by middle childhood (e.g., Harris et al., 2006; Kalish, 1996; Lane, Wellman, & Evans, 2012; Richert & Harris, 2006). For example, consider germs; by 3.5 years of age children often account for people's illness in terms of their having come into contact with germs (Legare, Wellman, & Gelman, 2009), and by 4 or 5 years children often *predict* that individuals who come into contact with germs will get sick in the future (Kalish, 1996). However, little is known about how young children draw inferences based on newly acquired information about invisible entities. When young children are first introduced to novel invisible entities that purportedly produce observable phenomena, do they report that future instances of those phenomena were produced by those invisible entities? If children are never explicitly taught about the invisible entities, do they then infer their existence to account for observed phenomena? If children do infer the existence of such entities, can they then use their knowledge of the entities to produce novel outcomes? We addressed these questions with the current studies. In what follows, we briefly review the literatures on children's understanding of invisible entities and their understanding of causality.

Prior work demonstrates that young children can and do impute the existence of *certain* invisible entities to account for observable phenomena. Children (and adults) make sense of other people's overt behavior in terms of unobservable desires, knowledge, and beliefs (Wellman, 2014). As well, in some cultures children and adults attribute an invisible "life force" to living beings (Inagaki & Hatano, 2004). Does this early facility in imputing such entities imply that young children readily infer and easily learn about the existence of all types of invisible entities? Not necessarily. Developments in one domain (e.g., naive psychology) do not necessarily parallel developments in other domains (e.g., naive physics) (Wellman & Gelman, 1998). Thus, young children's ability to impute invisible psychological or vitalistic entities is not sufficient evidence for how they make inferences about and learn about other types of invisible entities. In addition, minds and life forces are special kinds of invisible entities. For one, both are always "contained" in other things (i.e., living organisms; or at least they co-occur with the presence of those things); thus, although they are occluded from view, they nevertheless always have an observable physical presence. But many invisible entities are consistently and completely invisible. Indeed, causally potent invisible entities surround us; some are in the air we breathe (oxygen) or on our bodies (germs), some are part of nearly everything in existence (atoms), and others are purported to be *everywhere* (the Judeo-Christian God)—and (unlike minds and life forces) their causal power moves clandestinely from place to place with them. Acknowledging the existence of these entities requires setting aside what we do see (nothing) to entertain the notion that something is indeed there.

Young children are competent causal reasoners and are even capable of reasoning about certain unseen entities. Preschoolers can imagine that a familiar substance being applied to an object will yield a familiar effect; for example, if in a pretend context milk is "poured" from an (empty) milk carton into a container and that container is then inverted over a toy horse, children imagine that the pretend milk has made the horse "wet" (Harris, Kavanaugh, & Meredith, 1994). By 2 years of age, children imagine such causal chains and can identify the correct outcome (from several possibilities) even when the entire sequence of events occurs out of sight (Ganea, Shutts, Spelke, & DeLoache, 2007). Other work reveals that 3- and 4-year-olds infer the identity of novel objects based on their observed