**Opening the black box of early depiction interpretation:
From *whether* to *how* in the Theory-of-Puppets debate**
Commentary on Kominsky, Lucca, Thomas, Frank, & Hamlin (submitted)

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Abstract

The use of animations and puppet shows in developmental research has recently been questioned on external validity grounds: do infants and children interpret schematic, depictive stimuli (e.g., animated shapes, wooden circles) as required for a given measure of interest (e.g., as agents)? Kominsky *et al.* (submitted) provide good evidence that the answer to the *whether*-question is, in many cases, affirmative. The theoretical question concerning *how* they do this remains, however, open. We present the standard answer to the *how*-question (these stimuli satisfy the input conditions of the cognitive domain under investigation) and contrast it with the under-explored possibility that these stimuli are interpreted in the same way in which they have been generated (i.e., as representations).

Keywords: Development; Infant; Cognition; Depictions; Representations; Methodology¶

The external validity of developmental research has recently been challenged because conclusions about psychological capacities are based on infants' and children's reactions to stimuli which are quite different from the situations they encounter in the wild: shapes on the screen, wooden circles, and puppets (Packer & Moreno, 2020). What justifies our inference that infants attribute goals, beliefs, and moral dispositions to actual agents given that we only measure their reactions to entities that are mentally inert?

Taking up the challenge, Kominsky and his colleagues wrote a thoughtful reply on the unavoidable trade-off between internal and external validity, emphasizing that the right balance is even more challenging to strike for developmental research than for research with adults. Not only does simplicity allow for better experimental control over the measure of interest, but it might also be necessary to tap into infants' conceptual workings because of infants' inherent processing limits. In short, simple stimuli in infancy research are useful because they reduce both the number of potential confounds and the risk of masking an underlying ability.

Kominsky and his colleagues go on to cite evidence from the social cognition literature indicating that infants respond to schematic stimuli as they do to live ones in a variety of cases (e.g., preference for schematic faces, puppet imitation, and gaze following). This suggests that they are able to extract the content embedded in depictions in precisely the way in which the experimenters intended them to.

While we fully agree with this line of reasoning, we would like to point out that the main question which sparked this debate is actually twofold. On the one hand, the question asks *whether* simplified stimuli are tapping into what they are meant to measure. From a pragmatic perspective, an affirmative answer to this question is enough to address validity concerns; and we think that Kominsky et al.'s response successfully alleviates most of these worries. If these stimuli do convey the construct of interest to infants, research is back on safe epistemic grounds—on condition that researchers check this assumption by comparing schematic stimuli to ecologically valid ones or by validating them with older participants. But there is a second aspect to the question which, we think, has been black-boxed in the debate so far: *how* do these stimuli convey the construct of interest in infancy and beyond? While

not of immediate interest for drawing conclusions about infants' psychological capacities in a specific domain of investigation, we believe the *how*-question raises valid theoretical points and may call attention to further cognitive capacities that remain masked by focusing on the *whether*-question.

The standard answer to the *how*-question exploits some version of the proper-actual domain distinction (Millikan, 1984; Sperber, 1994): cognitive mechanisms designed to handle a specific class of stimuli in the real world (e.g., the faces of our conspecifics) will respond to stimuli outside the class as long as those stimuli satisfy the input conditions of the respective mechanism (e.g., schematic drawings, puppets with eyes). In the case of agents, intentions, goals, and mental states will be attributed from infancy onwards whenever animacy cues are present (Scholl & Tremoulet, 2000; Spelke & Kinzler, 2007). From this perspective, researchers need only hit on the right input conditions when designing their stimuli in order to tap into the cognitive subsystem of interest.

There is, however, an alternative to the standard view, which has received little attention in the literature (see Asaba, Li, Yow, & Gweon, 2020, for an exception). Following Clark (2016), Kominsky and his colleagues acknowledge that animations and live puppet shows are depictions of agents and their interactions. This, at least, is how they are *generated* by the experimenters. Physical entities (props in puppet shows, unitary pixel constellations in animations) are used to create scenes through which other entities (fictional agents, in this case) and the relations between them are represented. The proposal we would like to put up for discussion is that this may also be how they are *interpreted*, i.e., as representations. From this perspective, researchers need only provide sufficient iconic and/or linguistic evidence for the conceptual content of the representation to be extracted. (As a side note, these requirements are precisely the ones people must meet when designing depictive representations more broadly: infographics, pedagogical animations, assembly instructions, or scientific figures.)

At first glance, this proposal seems implausible on empirical grounds. Many experimental findings suggest that infants and young children struggle with linking a visual representation or a model to the object or state of affairs it represents (see DeLoache, 2004,

for a review). How could they link a wooden circle to anything? Note, however, that these findings are only relevant for a particular type of representation, in which the information is about an *actual* object or state of affairs. But depictive representations are often not referential in this sense at all. Adults and children can draw a unicorn or a generic house, and these drawings are representations all the same even though there is no actual object in the world which they can be linked to (Goodman, 1976).

A second argument for this interpretation comes from object substitution pretense, where the capacity to set up links between a physical object and a fictional entity is manifested early on in development. A wealth of evidence shows that children can flexibly assign pretend identities to arbitrary objects (a banana as a phone) and track the information predicated about the fictive referent (the phone) based on the actions performed on the object in front of them (the banana) by 2 years of age (Harris & Kavanaugh, 1993), if not earlier (Bosco, Friedman, & Leslie, 2006). If animations and puppet shows are interpreted on the same par with pretend play, the claim that infants set up representational relations between live or animated objects and whatever it is they depict (at least from some point in development onwards) becomes a serious competitor for the standard view, which cannot make sense of pretense at all. For object substitution pretense, it would be difficult to claim that a wooden block satisfies the input conditions of anything, since children can accommodate multiple pretend identities of the same object across different contexts and speakers (Wyman, Rakoczy, & Tomasello, 2009).

In sum, we found the recent debate over the nature of the stimuli used in developmental research highly relevant from both a methodological and theoretical perspective. While we concur with Kominsky and colleagues in rejecting the claim that conclusions drawn from lab research are invalidated by the use of simplified depictions (the *whether*-question), we think that the cognitive mechanisms underlying the interpretation of depictions warrant further theoretical thought as well as more empirical investigation (the *how*-question).

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