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Experience matters: 11-Month-old infants can learn to use material information to predict the weight of novel objects

Petra Hauf[a,*], Markus Paulus[b]

[a] St. Francis Xavier University, Antigonish, Canada
[b] Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, Nijmegen, The Netherlands

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ABSTRACT

In contrast to previous findings, this study demonstrates that 11-month-old infants are able to learn the relationship between object material and object weight when exploring different objects that provided a systematic covariation of both object features. This guides their action in a subsequent preferential-reaching task.

Successful acting in the physical world requires sophisticated knowledge about the properties of objects and the kind of actions that they afford. A very important aspect in our interaction with objects concerns their material properties such as texture, rigidity and compliance. Indeed, research has provided evidence for the relevance of such information for the planning and guidance of our object-directed actions (e.g., Fikes, Klatzky, & Lederman, 1994). However, few are known about the way infants use knowledge about an object's material to guide their own actions.

Perception-action accounts of sensorimotor development have shown that infants learn about object properties through optimised perception-action routines (Bushnell & Boudreau, 1998; Gibson & Pick, 2000) and that infants also integrate that information into their object-directed actions (Berger, Adolph, & Lobo, 2005; Bourgeois, Khawar, Neal, & Lockman, 2005; Rochat, 1987). However, an important characteristic of our physical environment is that it consists of regularities, so that knowledge about one object property allows us to conclude on other properties and adapt our actions even proactively (cf. Baillargeon, 2002; Hauf, Paulus, & Baillargeon, in press; von Hofsten, 2007). An important regularity is thereby the relation between an object's material and its weight as knowledge about an object's material allows us to conclude on its weight and to guide our actions thus prospectively (cf. Smith, Carey, & Wiser, 1985).

In a recent study Paulus and Hauf (2010) investigated infants' ability to employ information about an object's material to subsequently adapt their object-directed actions with differently weighted objects. To this end, 9- to 13-month-old infants played in an exploration phase with two objects made of different materials, one very heavy and the other one light and playable. Subsequently, when given the choice between both objects in a preferential reaching task only the 11-month-olds but not the 9-month-olds used the object's material information to remember the lighter object and reach for it. Importantly, when novel objects made of the same materials were offered, only the 13-, but not the 11-month-olds reached for the objects

* Corresponding author at: Department of Psychology, St. Francis Xavier University, P.O. Box 5000, Antigonish, NS, B2G 2W5, Canada. Tel.: +1 902 867 5041; fax: +1 902 867 5189.
E-mail address: phauf@stfx.ca (P. Hauf).

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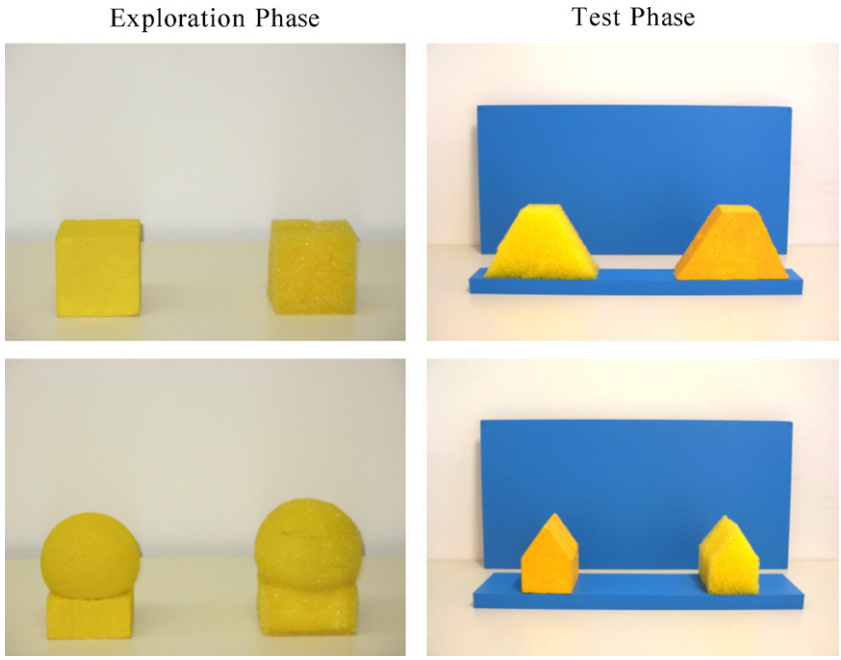

Fig. 1. Stimuli used during exploration phase and test phase. The left panel displays the sponge and Styrofoam cubes as well as the sponge and Styrofoam globes of the exploration phase. The right panel shows the test planks with a sponge pyramid and a Styrofoam pyramid as well as a sponge house and a Styrofoam house used in the test phase.

made of the same material as the light object explored earlier, suggesting that infants at the beginning of the second year identified material information as a valuable predictor of an object's weight.

An important question concerns the subserving mechanism of infants' ability to predict the weight of novel, yet unseen objects. In particular, the question arises if infants' identification of the relation between material and weight is based on their experiences with different objects of the same material type. Preliminary support for this hypothesis comes on the one hand from studies on infants' ability to learn rules showing that already young infants can learn about rule-like relations between single elements (e.g., Saffran, Pollak, Seibel, & Shkolnik, 2007). On the other hand, support is provided by violation-of-expectation based studies on infants' physical learning that investigated the conditions that promote the acquisition of physical knowledge in infancy (e.g., Wang & Baillargeon, 2008; Wilcox & Chapa, 2004). In particular, it has been suggested that additional experience with physical events facilitates infants' ability to identify relevant variables and helps them to predict the outcomes of physical events (Wang & Baillargeon, 2008). Based on the hypothesis that additional experience with single instances of the same category enhances infants' learning, we investigated, if additional manual experiences with different objects, whose material and weight systematically covary, would enable 11-month-old infants to predict the weight of novel objects made of the same material.

To this end, our study closely followed the design of Paulus and Hauf (2010) with the crucial difference that the 11-month-old infants did not play with one object but with two objects of each material. The objects that were made out of one material were very light so that they afforded a lot of actions and the objects made of the other material were so heavy that infants could not easily manipulate it, inducing thus a preference for the lighter objects (Paulus & Hauf, 2010). Afterwards, in four test trials, novel objects were presented to the infants, which were identical with respect to the material of the objects infants played with in the exploration phase. By measuring their preferences for one of the two objects, we aimed at discovering if the infants would preferentially reach for the objects that consisted of the material that has been the lighter one during the exploration phase. That would indicate that the additional experience enhanced their ability to use material information to infer the weight of novel objects.

The final sample consisted of 16 healthy term 11-month-old infants (*M*: 10 months, 3 days; *range*: 10 months, 19 days to 11 months, 24 days; 8 boys). Two additional infants were tested but not included in the final sample because of refusal to remain seated and because of an experimental error. The objects used during the exploration phase were two yellow sponge cubes, two yellow Styrofoam cubes, two yellow sponge globes, and two yellow Styrofoam globes (see Fig. 1) (For interpretation of the references to colour in this sentence, the reader is referred to the web version of the article.). Pilot studies had revealed no preference for one or the other material. Each object had an axis of 10 cm. By inserting lead, a light (200 g) and a heavy version (2000 g) were produced of each type of object. During the test trials two wooden platforms (50 cm × 10 cm × 2.5 cm) with two novel objects (houses and pyramids) were presented. The experimenter offered one test platform during the first and second test trial (e.g., the houses) and the other plank during the third and fourth test trial (e.g.,