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When do infants understand that they can obtain a desired part of a composite object by grasping another part?

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ABSTRACT

When do infants start to understand that they can grasp an object by its handle when the interesting part is out of reach? Whereas it is known from preferential looking tasks that already at three months of age infants show surprise when all parts of an object do not move together, little is known about when infants are able to use such knowledge in an active grasp situation. To answer this question we presented six, eight, and 10 month-old infants in a cross-sectional and a longitudinal study with a white cardboard handle within reach and a bright ball at the end of the handle and out of reach. A trick condition, where the handle and the ball seem attached but were not, was added to get an indication of the infant's expectation by observing a possible surprise reaction.

Results show that 6-month-olds' most frequent first behaviors consisted in pointing toward the ball without grasping the handle, or grasping the handle without looking at the ball until it moved. In addition, they often did not look surprised in the trick condition. Eight- and 10-month-olds most often grasped the handle while looking at the ball, and showed clear surprise in the trick condition. This was interpreted as showing that around eight or 10 months, infants take a significant step in understanding the cohesiveness of composite objects during grasping.

1. Introduction

Grasping composite objects is an everyday experience, as, for instance, when grasping a cup by its handle. A particular case is when the salient and desired part of a composite object, for example the food part of a lollipop, is too far away to be grasped directly: in that case, we take for granted that we can retrieve the desired part by using the part of the object which is within reach, often a handle. This is because we know that all parts of a composite object move together. But this principle, which seems totally obvious to adults, may not be so obvious to infants. The literature on this question does not provide very much information.

Thus, while a large amount of work has been done on how grasping emerges and becomes adapted to the shape of an object around 5 months (Hofsten, 1984; Hofsten, 1986; Mathew & Cook, 1990; Thelen, 1992; Thelen, Corbetta, & Spencer, 1996), much less is known about infants' understanding of composite objects. Some work related to this question has been

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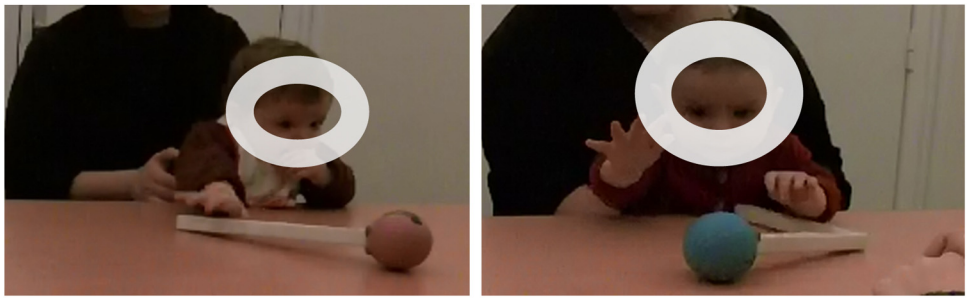

Fig. 1. (a) Straight object, handle to the right (infants grasps the handle while looking at the ball, level 3); (b) L-shaped object, handle to the left (infant points to the ball, level 1).

done using the technique of visual habituation (e.g. Cheries, Mitroff, Wynn, & Scholl, 2008; Spelke & Van de Walle, 1993; see the review by Spelke & Kinzler, 2007). This work has shown that infants are sensitive quite early to the physical laws that govern objects and in particular that infants possess the notion of the cohesiveness of a rigid object (an object must maintain a single bounded contour over time). For instance, three-month-old infants show surprise when all parts of an object do not move together (Spelke & Van de Walle, 1993).

However, a problem with such visual habituation studies is that the results do not necessarily generalize to tasks where actual physical actions are involved: a substantial discrepancy has been observed between the age at which infants display perceptual knowledge and the age at which infants are able to use this knowledge for action. For instance, visual habituation studies show that the principle of solidity (an object cannot move through a solid barrier) seems to be understood at three months (Spelke, Breilinger, Macomber, & Jacobson, 1992), but two-year-olds still open the door beyond an obstructing panel to reach for a rolling ball that disappeared behind an occluder, giving the impression that they do not expect that the high panel visible above the occluder will prevent the ball from rolling (Berthier, DeBlois, Poirier, Novak, & Clifton, 2000). Thus, in the case of a composite object, though it is known that infants already show surprise at three months of age when all parts of an object do not move together (Spelke & Van de Walle, 1993), one can wonder at what age they are actually able to manually grasp a composite object by one part in order to retrieve a different, more interesting, part. This is the question asked in the present study.

A clue toward an answer to this question might be found in the classic means-end studies involving cloth-pulling, string pulling, cane pulling, etc. first explored by Richardson (1932), Piaget (1963), Uzgiris and Hunt (1975), Bates, Carlsonluden, and Bretherton (1980) or Willatts (1984). These studies show that around 9–10 months, infants have sufficient understanding to be able to pull a string in order to retrieve an out-of-reach toy. Using the string-pulling paradigm, other studies have aimed at understanding action representations with respect to an ultimate goal and their relation to the ability to produce similar sequences (Sommerville & Woodward, 2005). For instance, Sommerville and Woodward showed that 10-month-olds can identify the goal of string-pulling when they watched an actor doing it, but only if they could themselves "planfully solve a similar sequence" (Sommerville & Woodward, 2005, p.1; see also McCarty, Clifton, & Collard, 2001; McCarty, Clifton, & Collard, 1999). But these tasks could be understood as means-end problem-solving tasks involving not one composite object but rather two distinct objects with one desired object and another object which is a means to retrieve it. Conceptually therefore, it seems reasonable to think that such means-end tasks might constitute a more complex problem to the child than the simple task of exploiting an object's rigidity to bring closer an unattainable part of the object. Indeed, children are exposed to the coherent motion of solid objects from birth on, and it seems plausible that their early accession to the notion of object precisely requires them to understand that parts of an object all move together. The intutition would thus be that such very basic understanding, which underlies the notion of object, has a different status and might develop differently from the conceptually more complex ability to solve means-end tasks like the string pulling task. Our purpose here was therefore to contribute to the understanding of the development of this cohesiveness or composite object notion.

To this end, we performed a cross-sectional and a longitudinal study. We presented 6- to 10-month-old infants with a brightly decorated ball attached to the end of a featureless white cardboard handle (see Fig. 1). Pilot experiments previously performed in a day-care nursery had confirmed that such a featureless handle was much less desirable than the ball, since when handle and ball were placed in front of children, after looking at both, they invariably chose to play with the ball. We used two types of handle, a straight handle and an L-shaped handle. Our intuition was that the L-shaped handle, being more unusual in shape, and providing a less direct connection from the handle to the ball, might tax the infant's comprehension to a greater extent. The object was presented so that the handle was within reach, but the ball was out of reach. We observed to what extent infants simply begged for the ball and ignored the handle, or to what extent they realized that grasping the handle would allow retrieval of the ball. Investigating the infant's visual understanding of object structure in grasp planning by observing looking and manual behavior before grasping has previously been used, for instance to check the infant's anticipation of the solid versus flexible quality of the object (Barrett, Traupman, & Needham, 2008), or its understanding of "connectedness" (Rat-Fischer, O'Regan, & Fagard, 2014). We added an additional 'invisible disconnection' condition to help disambiguate the results. We assumed that this trick condition would elicit surprise only when the baby understood