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Infants' agent individuation: It's what's on the insides that counts

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ABSTRACT

Adults and preschool-aged children believe that internal properties are more important than external properties when determining an agent's identity over time. The current study examined the developmental origins of this understanding using a manual-search individuation task with 13-month-old infants. Subjects observed semi-transparent objects that looked and behaved like animate agents placed into box that they could reach but not see into. Across trials infants observed objects with either the same- or different-colored insides placed into the box. We found that infants used internal property differences more than external property differences to determine how many agents were involved in the event. A second experiment confirmed that this effect was specific to the domain of animate entities. These results suggest that infants are biased to see an agent's 'insides' as more important for determining its identity over time than its outside properties.

1. Introduction

The way we reason about other people is fundamentally biased towards properties that lie beneath the surface. When making basic decisions about who someone is and how they are likely to behave we often ignore salient surface properties in favor of more internal and unobservable features. For example, adults judge whether a person is the same individual over time based on psychological properties like memory (Blok, Newman, & Rips, 2005; Rips, 2011), and represent that people from the same social group share similar beliefs even though they differ in their external appearance and behaviors (Hirschfeld, 1996). This bias sometimes manifests itself as a biological attribution where an agent's 'insides' are seen as being a greater determinant of its identity than whatever surface properties it may exhibit (Medin & Ortony, 1989; Newman & Keil, 2008; Taborda-Osorio & Cheries, 2017).

Young children's explicit judgments reveal an early understanding that internal properties are more relevant than external properties when reasoning about agent identity. For example, 4-year-olds infer that animals belonging to the same category are more likely to share more internal, non-observable properties than external and observable ones (Gelman & Markman, 1986). When internal and external properties are pitted against each other in a categorization judgment task 5-year-olds reliably use internal physical properties such as blood or bones to categorize animals but not artifacts (Diesendruck, 2001; Diesendruck, Gelman, & Lebowitz, 1998; Diesendruck & Peretz, 2013). Furthermore, 7-year-old children who observe salient changes to an animal's external appearance insist that the animal's categorical identity remains unchanged, such that a tiger with its stripes erased is still a tiger (Keil, 1989). On the other hand, when preschool-aged children are told that the *insides* of an animal are removed or changed they infer that their categorical identity should change as well (Gelman & Wellman, 1991). The same pattern of results has been found when children evaluate the individual identity of an animal across transformations by using internal psychological properties (Gutheil & Rosengren, 1996). For instance, children as young as 4 years of age know that an animal's food and behavioral preferences (e.g. a dog liking to chew bones) remain stable regardless of salient surface transformations.

Since children seem to apply these beliefs to living things and not to simple artifacts (Gelman & Wellman, 1991) some researchers have proposed that this type of reasoning reveals biological essentialist beliefs in children (Ahn et al., 2001; Gelman, 2003; Hall, 1998; Meunier & Cordier, 2009). From this perspective, natural kind objects, but not artifacts, are represented as possessing an underlying reality which is causally responsible for the pattern of observable features (Gelman, 2004; Medin & Ortony, 1989). As a consequence, non-visible properties such as an agent's insides are regarded as more relevant and diagnostic of identity than any external properties.

When over development does this sensitivity to internal features in biological functioning emerge? Some evidence indicates that direct experience with the biological world and explicit instruction about biology may mediate changes in the way children represent the causal role of animals' internal properties (Rhodes & Gelman, 2009). However, more recent studies suggest that an early form of this understanding

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could also emerge from more elemental cognitive biases that allow infants to represent animals' intrinsic properties and prioritize them over their external properties under some circumstances. For example, by 8 months of age, infants expect that an object that looks and acts alive should possess some physical internal properties (Setoh, Wu, Baillargeon, & Gelman, 2013). In this study infants who were shown objects displaying both self-propelled movement and agentive cues (e.g. being all covered with fur), looked longer when the biological agents appeared to be hollow rather than full on their insides. This suggests that infants may represent internal features as a biological property that is unique to entities that look and behave like animals. This pattern of results is consistent with an early developing "innards" principle (Gelman, 1990), the belief that something inside the animal is causally responsible for self-propelled movement (internal energy) and agency (internal states).

Beyond the general expectation that self-propelled agents have insides, infants have also been shown to make more specific inferences in the reverse direction—first observing an agent's internal properties and then using those features to create novel categories or to infer various behavioral properties. For example, 14-month-old infants will treat novel animate objects as if they belong to the same category when they share similar insides, while inanimate objects are categorized based on their external appearance (Welder & Graham, 2006). At this same age infants will also automatically associate an agent's idiosyncratic movement to the color of an internal part rather than to a salient external feature and generalize this association to other animate objects with the Different Outsides, despite their 'outsides' being perceptually distinct (Newman, Herrmann, Wynn, and Keil (2008). Furthermore, infants only seem to prioritize internal features when the objects in such tasks exhibit self-propelled behavior; when objects were moved by external means infants did not show a bias toward internal features (Newman et al., 2008).

Overall, the developmental research described above suggests that infants represent an agent's internal properties as more relevant than its external features when forming new categories or generalizing properties across individuals. Additionally, some of this evidence suggests that the internal features may be represented as a biological property, presumably with causal potency (e.g., Setoh et al., 2013). However, these prior results leave open an important question regarding how internal properties relate to infants' representations of agents—do infants represent an agent's 'insides' as more strongly connected to its individual *identity* than its external properties? In previous tasks, infants may have associated an internal feature with a particular movement type without necessarily treating an agent's insides as a powerful cue that determines whether they are the *same* agent over time. If infants represent insides as a biological property, then they may regard them as more diagnostic than external, non-biological, properties in an identity judgment. In this way 'insides' would not be represented merely as a distinctive property of animate entities, but also as an essential feature that helps distinguish both the individual and categorical identity of agents through changes over time.

The question of how infants represent the identity of objects over time has been most commonly addressed in the developmental literature through so-called individuation experiments. In the classic version of these experiments infants witness various objects move in and out of view from behind an opaque barrier. Afterwards, the screen is lifted to reveal the number or objects involved in the event and infants' looking-time responses are recorded. Experimenters estimate the number of objects that were represented based upon observing how long infants look at displays containing either 1 or 2 objects (for example see Xu & Carey, 1996). Since infants might only see one object appear from the barrier at a time, experimenters can determine which features (color, shape, texture, etc.) infants use to represent the objects as separate individuals. Some of these individuation experiments have demonstrated that infants sometimes disregard superficial perceptual features and use abstract conceptual information to individuate objects (Kingo & Krojgaard, 2011; Xu & Carey, 1996; Xu, Carey, & Quint, 2004; Xu, Carey, & Welch, 1999). For example, 10-month-old infants represent two objects behind a screen when one object displays a self-propelled movement while the other one's motion appears externally-caused (Surian & Caldi, 2010). By contrast, infants fail to represent two objects behind the screen when two agents with different superficial features are presented. This pattern of results suggests that infants are able to use the abstract ontological distinction between "agent" and "inert object" to represent object identity.

These prior individuation studies demonstrate that from very early on infants represent some non-obvious properties (e.g., self-propelled motion) as more important than surface features when representing object identity. One intriguing possibility is that infants attribute such non-obvious properties to an agent's physical 'insides' as an initial placeholder for what determines an agent's appearance, behavior, preferences, and most basically, its identity as an individual. However, no prior experiment has determined whether infants spontaneously use biologically based cues such as an agent's 'insides' to establish representations of new individuals. The purpose of the current experiment was to examine this possibility by using a manual-search version of the classic individuation task (Feigenson & Carey, 2003; Van de Walle, Carey, & Prevor, 2000). In this paradigm infants observe one or more objects being placed inside an opaque box, which they can reach but not see into. The number of individual objects the infant represents is then estimated by observing the duration of their subsequent reaches into the box (e.g., a representation of two objects inside the box will lead infants to engage in a longer search duration than a representation of one object). In order to determine whether infants are sensitive to an agent's 'insides', we systematically manipulated whether changing the internal or external features of transparent objects hidden in a box would affect their individuation judgments. In order to test whether a sensitivity to internal properties was specific to agents, we manipulated whether the stimuli did or did not display agent-like cues (i.e., possessing eyes and exhibiting self-propelled movement; similar to those used in Newman et al., 2008). We tested infants who are approximately 13 months, an age that aligns with prior individuation demonstrations using this task (e.g., Feigenson & Carey, 2003) and demonstrations of infants' sensitivity to internal properties (Newman et al., 2008).

Experiment 1 was designed to test two hypotheses: first, that infants will represent differences in an agent's *internal* properties as highly diagnostic of a change to the agents' identity even when external properties remain the same; and second, that infants will represent differences in an agent's *external* properties as less diagnostic of a change to the agent's identity when internal properties remain the same. Experiment 2 was designed to test the hypothesis that the connection between an individual's 'insides' and its identity should be stronger for agents than for inanimate objects. Experiment 3 replicates the results of Experiment 1 and controls for possible stimulus-based effects.

2. Experiment 1

2.1. Method

2.1.1. Participants

Sixteen 13-month-old infants participated in this experiment (mean age = 13 months and 12 days, SD = 8 days). Half of the infants were girls. All infants were recruited from the Amherst, Massachusetts area. An additional 6 infants were tested but were excluded because of fussiness (2), experimental error (1), and disinterest (3). Fussiness was operationalized as instances where infants showed irritation along the experiment, for example, by crying or hitting the materials on the table. Disinterest was operationalized as instances where infants did not focused their attention on the task and did not try to reach into the box.