Children's Belief in Counterintuitive and Counter-perceptual Messages

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Abstract

Children’s cognition is shaped, in part, by the messages provided by parents, educators, and peers. Some of these messages defy children’s own knowledge or perceptions—these claims may be confronted regularly in science classes and museums (e.g., when learning about invisible gases or species categorization) and in religious settings (e.g., when learning about all-powerful deities, souls, or qi). How are children’s beliefs influenced by these counter-messages? Using a constructivist framework, I review research to chart a developmental account for how children adjust their beliefs in response to counterintuitive and counter-perceptual messages. I focus on how and why children's receptivity to such claims shifts across development, and I discuss cognitive and contextual factors that influence these developments.

Children's Belief in Counterintuitive and Counter-perceptual Messages

Children's cognition is shaped, in part, by messages provided by others. These messages are critical to understanding science, society, and spirituality because they convey information that learners may be unable to access on their own, including ideas about microscopic organisms, other cultures, historical events, invisible deities, and souls. For decades, researchers have explored how messages delivered in formal and informal contexts influence children's knowledge and concepts (e.g., 1, 2). However, only recently have researchers made a concerted effort to examine whether and when children *believe* what they are told (3). An intriguing segment of this work includes studies of children's belief in messages that are inconsistent with their perceptions or concepts; children may regularly confront such messages in science classes and museums (e.g., when learning about invisible gases or species categorization) and religious settings (e.g., when learning about all-powerful deities, souls, or qi). How are children's beliefs influenced by messages that contradict their knowledge or perceptions?

In this article, I review recent research to chart a developmental account of how children adjust their beliefs in response to messages that are inconsistent with their perceptions and concepts. My account is informed, in part, by contemporary constructivist theories (e.g., 4). Constructivist theories were designed to account for conceptual development—individuals construct concepts gradually as they reconcile their knowledge of specific domains with new data (typically, data perceived first-hand); new concepts then support and constrain later conceptual change. I contend that a constructivist perspective can also help account for children's beliefs in others' claims—children's knowledge can lead them to either reject claims or adjust their beliefs, depending on the strength of their knowledge and beliefs, the robustness of the new information (e.g., amount of exposure to the new information, the number of

informants, informants' expertise), and the degree to which beliefs and social messages conflict. Although the content of beliefs varies across development and contexts, some of the same underlying processes will govern belief revision across the lifespan, beginning in infancy.

Developmental Trends: Belief in Counter-perceptual and Counterintuitive Messages

Psychologists, philosophers, and even some biologists have suggested that children are prone to believe everything they are told (e.g., 5, 6). However, consider the implications of such gullibility: Upon hearing someone make a claim—accidentally, playfully, or deceptively—that is inconsistent with her own perceptions or knowledge, the universally gullible child would immediately override those perceptions or that knowledge to accept the new message. How would that influence other concepts constructed on the replaced knowledge? What if a child were to hear a message the next day that contradicted the last one; would she believe both? As Perner (7) noted, if children's knowledge was causally linked exclusively to linguistic input, their "knowledge base would become alarmingly unstable" (p. 145). Young children must approach others' messages differently. Indeed, recent research has revealed that, rather than accepting everything they are told, children are much more discerning than once thought.

Counter-perceptual Messages

Infants understand that people's claims are not always trustworthy and express skepticism toward certain claims remarkably early in life (for a review, see 8). In one study, 16-month-olds were told incorrect labels for familiar entities (e.g., a speaker called a duck a "ball"). Many of these infants stared at the speaker, presumably confused (9). In other studies, when 2-

year-olds were offered such labels, they often disagreed with the speaker verbally (e.g., “No.”) and sometimes corrected them (e.g., “No. Duck.”; 10, 11).

Research with slightly older children underscores the magnitude of their skepticism toward counter-claims. In one study, children watched as a ball fell into one of three transparent cups, then an experimenter claimed the ball was in a different cup (12, Study 3). When asked to find the ball, 2½-year-olds typically identified the ball’s actual visible location. In work on children’s susceptibility to consensus, children were shown lines of varying lengths and watched three adults claim that the line that was objectively the shortest was the longest (13). When asked to identify the longest line, most 3-year-olds chose the line that was objectively the longest, ignoring the consensus. In summary, when testimony completely contradicts what they are looking at, very young children typically reject those claims.

When children hear claims that contradict their *past* perceptions, the results are more nuanced. In one study, children watched as an object was placed in an opaque box, then two informants looked in the box and claimed that the object was a different color than what children had seen (14). When asked about the object’s color, 3-year-olds reported what they had seen, rejecting the claims of both informants. In other studies, children watched as an object either fell into or was placed into one of several opaque containers, then experimenters claimed inaccurately that the object was in a different container (12, 15). Asked to retrieve the object, 2½- to 3-year-olds often followed the informant’s claim, whereas 4-year-olds relied on what they had seen. These apparently conflicting findings for 2½- and 3-year-olds might reflect differences in the strength of children’s knowledge of the transmitted information. Children might have stronger mental representations of relatively stable facts (e.g., objects’ colors) than of fleeting states (e.g., objects’ locations). Indeed, in other studies, when children were provided more

opportunities to interact with and observe the novel stimuli (and thus form stronger mental representations of that information), 2½- to 3-year-olds later *rejected* informants' counter-claims about objects' locations (12, Study 4; 15, Study 2). Experience likely strengthened children's mental representations of the referents, leading to greater skepticism toward counter-claims (for a discussion of relations between experience and the strength of mental representations, see 16).

At this age, children also tend to defer to claims that are only *moderately* counter-perceptual. When asked to categorize visual hybrids (e.g., an animal with 75% catlike features and 25% doglike features; e.g., 17), people typically categorize according to entities' dominant features (e.g., categorizing the entity that is 75% cat and 25% dog as a cat). But after hearing someone label the entities according to their less visually dominant category (e.g., calling the cat-dog a "dog"), 2- to 3-year-olds often categorized entities according to the new, moderately counter-perceptual labels (e.g., 17, 18). The acceptance of these labels decreases during early childhood; 5-year-olds typically reject the labels even when they are provided by several speakers (19).

What accounts for age-related decreases in children's acceptance of claims that are moderately counter-perceptual or that contradict prior perceptions? Some have proposed that this reflects shifts in children's ability to inhibit a bias to believe or that it reflects a decline in the importance of social goals (e.g., maintaining good relations) in favor of epistemic goals (i.e., acquiring knowledge; 20). These factors might account for young children's behavior in some studies (21), but they do not sufficiently account for the broader set of developmental data. If toddlers have an uninhibited bias to believe or are motivated by social goals, why do they accept some claims (moderately counter-perceptual labels) but *simultaneously deny* other claims (completely counter-perceptual labels)? A stronger developmental account emphasizes children's

knowledge and the development of that knowledge. Consistent with constructivist theories (e.g., 4), toddlers and preschoolers reject claims more often when they have strong contradictory knowledge (9, 22). With continued experience, children's knowledge is enriched, leading to even stronger mental representations and beliefs, which then promote greater *resistance* to counter-claims.

Even when children believe counter-perceptual claims initially, such beliefs might be fragile and short-lived. In a longitudinal study, researchers explored the persistence of children's endorsement of counter-perceptual labels (23). In an initial session, preschoolers heard counter-perceptual labels for hybrid animals and objects, then were asked to categorize each entity. As in other studies, children often categorized according to the counter-perceptual labels. Upon retesting, children were again asked to categorize the entities. Among the counter-perceptual labels children had endorsed initially, children endorsed approximately 60% three weeks later and 40% six weeks later; they gradually reverted to categorizing based on their own perceptions rather than informants' counter-labels. Thus, even when children believe counter-perceptual claims initially, the force of those claims, or at least children's memory of them, fades over time (if claims are not repeated).

In summary, by the late preschool years, children are skeptical about a wide variety of claims that defy their perceptions, and this skepticism increases as counter-claims conflict with children's increasingly robust knowledge. However, development does not end with children rejecting all counter-perceptual messages; indeed, older children and adults hold many counter-perceptual beliefs. For example, individuals must go beyond their immediate perceptions to believe claims that Earth is a sphere, seahorses are fish, or invisible entities (e.g., germs, oxygen, ghosts) exist. In these cases, belief entails appreciating that appearances and realities can

conflict, a conceptual insight that develops during the preschool years (e.g., 24). Indeed, in recent studies, preschoolers with a more advanced understanding of the distinction between appearance and reality more often believed claims that objects differed from what they appeared to be (e.g., that an apparent rock was soap; 25), and more often believed that purported invisible entities exist (26).

Thus, increasingly robust knowledge about the referents of informants' messages can engender greater skepticism toward counter-perceptual messages. Simultaneously, the development of certain conceptual insights (e.g., understanding the distinction between appearance and reality) allows children to more fully mentally represent the purported information, potentially promoting belief. These two processes also govern children's evaluation of counterintuitive claims.

Counterintuitive Messages

Whereas counter-perceptual ideas defy current or recent perceptions, counterintuitive ideas defy more abstract concepts and expectations that stem from those concepts. Counterintuitive messages fall into two broad categories: Some ideas are plausible but counter beliefs about what is normative—for example, the idea of blue applesauce or of someone walking through fire. Other ideas run counter to arguably universal concepts of causal rules, violating children's (and adults') naïve theories of mind, body, or physics (27). These include the idea of one kind of animal transforming into another (which violates essentialist intuitions) or the idea of a person walking through a solid wall (which violates intuitions about object solidity). Young children are skeptical about both categories of ideas (28, 29). When asked whether plausible but non-normative phenomena (e.g., someone walking through fire) can happen,

preschoolers often report that they cannot; however, children 8 years and older often report that these phenomena can occur (e.g., 30). This developmental progression partly reflects changes in children's ability to reflectively identify and imagine what, if any, factors support or impede the non-normative events (30, 31). For events that violate robust causal knowledge (e.g., walking through a solid wall), preschoolers *and* older children typically report that such events cannot occur.

Whether claims influence children's beliefs about the possibility of purported events depends on the type of claim and the type of event. In one study, when speakers reported seeing nonnormative but plausible events occur first-hand ("I saw someone…"), preschoolers reported that these events could not occur (32). However, when speakers provided second-hand claims (e.g., "Someone told me they…"), preschoolers more often judged that the events could occur. Young children might have inferred that both the speaker and the unknown "someone" endorsed the event—that consensus boosted their belief. In another study, after speakers reported that novel animals with nonnormative but plausible properties (e.g., a fish that is as big as a car) were "real" (versus "not real"), 6- to 8-year-olds were more likely to categorize those animals as real (33, Study 2). Thus, counter-claims like these may quickly promote beliefs about nonnormative phenomena.

However, in these studies, claims had little influence on children's belief in phenomena that contradicted their robust knowledge of causal rules. Children continued to report that events like walking through a solid wall could not occur, regardless of whether they heard first-hand or second-hand claims (32), and they continued to categorize animals with biologically impossible qualities (e.g., snakes that eat lightening) as pretend even after hearing that they were real (33, Study 2). Children's belief in these types of entities and phenomena may be *nudged* when they

are provided with elaborate claims by experts. In one study (34), 3- to 8-year-olds watched videos of experts (who knew "all about" animals or machines, and dressed as either zookeepers or mechanics) describing novel entities with qualities that conflicted with children's causal knowledge of physics or biology (e.g., solid objects that sink into other objects, animals that never eat). Children's beliefs changed *somewhat* after they watched the experts' testimony—children shifted from being "very sure" to only "a little sure" that the entities could not have such purported properties. The magnitude of belief revision following testimony (relative to children's baseline beliefs, measured separately) was similar across the age range, but older children held firmer baseline beliefs that these phenomena could not occur.

How do children (and adults) eventually form *strong* beliefs in ideas that defy concepts embedded in their naïve theories, such as ideas of biological evolution or all-knowing deities? It is unlikely that firm belief in such concepts is fostered by a single message. Rather, belief is likely fostered by being *repeatedly* exposed to the counterintuitive idea, being surrounded by others who endorse that idea, and revising one's concepts to accommodate the new idea (3, 28, 35). Next, I discuss how these and other factors influence children's belief in counter-claims.

Factors That Influence Belief in Counter-perceptual and Counterintuitive Messages

Discrepancy Between Old and New

Much of the research I have reviewed highlights that children's belief in counter-claims depends on *how much* claims conflict with their perceptions and knowledge. Preschoolers are more receptive to counter-perceptual labels that contradict entities' appearances only moderately (rather than completely; 17, 22, 23, 25). Children ages 4 years and older express stronger belief in entities with purported capacities that accord with their intuitions than capacities that

contradict those intuitions (33, 34). Although claims can strongly and swiftly influence preschoolers' beliefs in the occurrence of non-normative events, similar claims have much less influence on their beliefs about events that defy their naïve theories (32). And preschoolers revise their beliefs more often after hearing claims about objects' properties that contradict their observations of inconsistent, probabilistic relations than after hearing claims that contradict their observations of consistent, deterministic relations (36). Thus, across many domains and stimuli, the more that claims deviate from children's perceptions and knowledge, the less likely they are to revise their beliefs (see also 37). The discrepancy between old and new changes with experience, as children's knowledge is enriched and their mental representations and intuitions strengthen, often leading to greater disbelief in counter-claims (34).

Context

When an individual's community endorses a particular counterintuitive or counter-perceptual idea, this leverages two factors that may boost belief—many informants who endorse the idea, and repeated exposure to the idea. For example, in the midwestern United States, children as young as 5 years who are more often exposed to messages about God (by attending Christian schools or attending church regularly) more often believe that God is aware of people's unspoken desires (38), an idea that contradicts intuitions about mental-physical causality (39). In this same region, children 10 years and older who are raised more secularly more often endorse the idea of biological evolution through natural selection, a notion that contradicts essentialist and teleological intuitions (40). Cross-cultural differences emerge for different concepts at different points in development. Conceptual development influences how children mentally

represent what they hear and thus influences the extent to which messages are counterintuitive (28).

Children's acceptance of counter-claims also varies across cultural contexts as a function of differing cultural norms. In one study (22), kindergarteners in Hong Kong endorsed fewer counter-labels for prototypical objects than did kindergarteners in the United States. Cultural differences in learner autonomy might account for these findings (22). Children from Hong Kong are more self-reliant academically than their U.S. counterparts, perhaps because of higher performance expectations and a greater emphasis on personal effort in achievement. Thus academic self-reliance might engender greater resistance to certain counter-claims.

Informants' Knowledge

Evaluating claims judiciously entails considering the quality of informants' knowledge—something that even preschoolers do. For example, when a speaker acknowledges that her claim is counter-perceptual ("You're not going to believe this, but…"; or "This looks like an X, but…"), children ages 4 years and older are much more accepting of moderately counter-perceptual labels for novel hybrid entities (17), and somewhat more accepting of completely counter-perceptual labels for familiar entities (25). Such statements establish the informant's and the child's *mutual* knowledge or common ground (41), signaling that the informant is not ignorant to the obvious and is intentionally (not mistakenly) providing the counter-claim. Children's belief revision also depends on speakers' purported knowledge and their domain-specific expertise. For example, preschoolers are more likely to believe counter-claims when informants profess knowledge and confidence ("I really know about [X]…") rather than ignorance and reticence (e.g., "I don't know anything about [X]. I'm just going to guess that…",

36). When learning about counterintuitive qualities of novel entities (e.g., an animal that never eats, a metal object that can sink through rock), children's beliefs are swayed more by informants with relevant expertise (e.g., an animal expert who introduces animals) than by informants with irrelevant expertise (e.g., a mechanical expert who introduces animals) (34). Thus, the quality of informants' knowledge can profoundly influence children's belief in counter-claims.

Looking Ahead

Two areas of research are integral to the continued study of children's belief in counterintuitive and counter-perceptual messages. First, individuals' mental representations are graded—some are weak and others are strong (16, 42). Likewise, individuals' beliefs vary in strength along a spectrum, so counter-claims could *incrementally* increase or *incrementally* decrease belief along that spectrum. Yet most studies on belief in counter-claims ask children to make dichotomous decisions (e.g., believe or not believe). To more precisely capture the nuance of belief revision across development, researchers should use continuous measures that capture the strength of children's initial beliefs and revised beliefs (e.g., 34).

Second, although the constructivist account I have outlined helps to account for much of the available data on children's belief in response to counter-claims, children's real-world beliefs are likely also swayed by factors that typically land outside of constructivist theories and that have received little empirical attention. Specifically, we need data on how emotional factors—including the emotional appeal of the purported ideas and learners' emotional ties to informants—influence children's belief in counter-claims. Continued research can reveal how cognitive, contextual, and emotional factors *collectively* account for the development of children's belief in counter-claims.

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