Concepts and Folk Theories*

Susan A. Gelman† and Cristine H. Legare‡

†Department of Psychology, University of Michigan, Ann Arbor, Michigan 48109; email: gelman@umich.edu
‡Department of Psychology, University of Texas, Austin, Texas 78712; email: legare@psy.utexas.edu

Abstract

Human cognition is characterized by enormous variability and structured by universal psychological constraints. The focus of this article is on the development of knowledge acquisition because it provides important insight into how the mind interprets new information and constructs new ways of understanding. We propose that mental content can be productively approached by examining the intuitive causal explanatory “theories” that people construct to explain, interpret, and intervene in the world around them, including theories of mind, biology, or physics. A substantial amount of research in cognitive developmental psychology supports the integral role of intuitive theories in human learning and provides evidence that they structure, constrain, and guide the development of human cognition.

Keywords

anthropology of mind, children, cognition, psychology, theory of mind, biological theories
INTRODUCTION

Human minds are dazzling in their variety and plasticity, and at no time is this more apparent than when considering the contents of the mind. What a person knows and believes is highly contingent on experience and enormously flexible in the face of competing sources of information. Bodies are construed as partible in Melanesia (Strathern 1988), mountains as agentive in Peru (de la Cadena 2010), and human origins as the result of divine intervention in the United States (Evans 2000). School children in Michigan believe that dancing in front of an open freezer will help ensure a snow day, whereas school children in Iowa believe placing a spoon under their pillow will do the trick. Surely no two individuals hold precisely the same beliefs. It is perhaps not surprising, then, that many scholars have avoided studying the content of belief systems—in favor of processes, structures, functions, or brain regions that are (believed to be) more stable, predictable, or universal. Nonetheless, in this article we focus precisely on mental content, because the mental representations that humans use to structure experience provide rich insights into how mind mediates world.

The vast and unwieldy topic of mental content can be fruitfully approached by examining the intuitive “theories” that people construct, including theories of mind, biology, or physics. Intuitive theories are not scientific theories—they are not formal, explicit, precise, or experimentally tested. Intuitive theories are implicit and imprecise, but as with scientific theories, intuitive theories have broad implications: They organize experience, generate inferences, guide learning, and influence behavior and social interactions. Most centrally, intuitive theories are causal and explanatory. Indeed, explanatory systems of knowledge are integral to human cognition and learning. A recurring theme is that intuitive theories are not neutral or passive snapshots of experience; they embody cognitive biases that influence thought and action.

OVERVIEW

This article reviews recent research in developmental, cognitive, and cultural psychology that examines intuitive theories and their implications. In so doing, we trace some important cognitive biases that structure and constrain their development. We also highlight the value of a developmental approach that examines how these theories emerge and change in childhood. The article is organized as follows: First, we briefly review the notion that knowledge is organized into commonsense theories. We then present two case studies of well-researched theories, in the domains of mind and living kinds. Each illustrates the components of a theory (ontology, causal principles, coherence, resistance to counter-evidence, and hypothesized unobservables). Next, we discuss an overarching issue that stems from the case studies: the coexistence of multiple explanatory frameworks. We end with a summary and discussion of the primary issues.

Concepts in Theories

Knowledge and beliefs are actively constructed on the basis of an interplay between data and theory (Waxman & Gelman 2009). Humans possess exquisitely well-tuned capacities to track and reason about sensory and perceptual evidence (using statistical and probabilistic learning), yet at the same time, they construct powerful causal theories (with domain-specific ontological commitments and coherence) that impose order on the evidence and guide interpretations. Knowledge cannot be reduced to one or the other approach (bottom-up or top-down) alone.

Evidence for the data-analytic capacity of humans comes from research showing that people are surprisingly skilled at noting and remembering patterns in experience. Passively listening to a 2-min sequence of nonsense syllables (badukibiramu...) is sufficient for college students and 8-month-old babies to
extract repeated regularities, such that certain sequences of syllables are heard as “words” and recognized in isolation (Saffran et al. 1996). This unsupervised (and untutored) learning does not require conscious awareness, and indeed appears to involve wholly separate neural signatures from conscious judgments of familiarity (Turk-Browne et al. 2009). Furthermore, perceptual experience affects the content of categories over development. For example, children start out quite open as to which categories they can learn, but then over time, they experience greater difficulty making discriminations to which they do not have experience. Thus, for example, infants are at first able to make discriminations across the world’s languages, but by about 12 months of age, they are able to discriminate only the phonemes in the native language they are hearing (Werker & Desjardins 1995). Likewise, infants are initially equally skilled at distinguishing faces across different racial and ethnic groups, but by approximately 9 months of age, they are more skilled at distinguishing faces within the racial/ethnic group to which they have had exposure (Kelly et al. 2007). Thus, perceptual cues and learning are important mechanisms for acquiring culturally specific norms and experiences.

Some have concluded, incorrectly in our view, that the impressive capacity to attend to and learn from sensory/perceptual input suggests that building a mind is an engineering problem in which the task is to take sensory input as the building blocks to increasingly complex structures (Sloutsky et al. 2007). It is important to note, however, that demonstrating sensitivity to perceptual cues does not demonstrate a lack of sensitivity to theories (Waxman & Gelman 2009).

Briefly, what do we mean by an intuitive theory? Components of a theory include ontological commitments, causal laws, coherence, resistance to counter-evidence, and unobservable or hidden constructs (Carey 1985, Wellman & Gelman 1998). Ontological commitments specify what sorts of entities participate in a theory. Thus, a person can be variously construed as a sentient being with thoughts and desires (theory of mind); a living member of the species *Homo sapiens* (theory of biology); a solid object with weight, mass, and momentum (theory of physics); a soul encased in a temporary physical body (theory of religion), etc. Causal laws provide framework cause-effect mechanisms that foster predictions and explanations (e.g., in a theory of mind, thoughts and beliefs motivate human behavior; in a theory of physics, one solid object colliding into another results in movement). Coherence refers to the interrelatedness of different concepts and beliefs. Thus, changing one belief in a theory would lead to a domino effect of other changes in belief (see Carey 2009, for examples of coherence in historical and childhood conceptual change). This is related to the idea that deeply held theories tend to be resistance to counter-evidence (e.g., if I think the world is flat, I will reinterpret evidence to fit this view) (Karmiloff-Smith & Inhelder 1978). Finally, theories entail unobservable processes and entities, such as gravity, quarks, essences, and phlogiston.

Statistical cues do not compete with theory construction; they are input for theory construction (Waxman & Gelman 2009). An especially compelling example of this relationship is that statistical regularities provide important cues to infer causation. For example, Gopnik and colleagues presented preschool children with a mechanical device that lights up and plays music when blocks of a certain type (“blickets”) are placed on it (Gopnik et al. 2001). The child’s task is to determine which blocks are blickets, given only patterns of co-occurrence between toy placement and causal effects (machine lighting up and playing music). Children are remarkably skilled at drawing sophisticated inferences about causality on the basis of these cues. For example, if the machine lights up when two blocks (A and B) are placed on it simultaneously and fails to light up when block A alone is placed on it, then preschool children infer that block B is a blicket. However, that these are causal inferences, and not just associative inferences, is clear as mechanism information is always decisive. Only associations that have a plausible underlying mechanism are deemed relevant.
(for example, if a block is placed near the machine but not without physical contact, a child no longer makes a causal inference). Children’s judgments are also influenced by whether an action is performed by the self or by another person (Kushnir et al. 2009), reflecting the intuitive assumption that one’s own actions are more agentive and effective.

There are three primary arguments for the significance of theories in everyday mental representations. First, similarity and frequency counts are insufficient to characterize human concepts and categories (Rips 2011). As James (1890/1981) noted, “We carve out order by leaving the disorderly parts out... We carve out everything, just as we carve out constellations, to suit our human purposes.” Thus, human concepts reflect human interests, needs, and goals (Murphy & Medin 1985). For example, when classifying items into categories, people do not attend solely to the frequency with which features have been associated with the category in the past; rather, features that are causes are weighted more heavily than features that are effects (Ahn 1998, Rehder & Kim 2010). If statistical cues compete with an a priori belief (e.g., children learn that a rabbit got sick after being scared, but they also believe that illness has a physical, not psychological basis), children are influenced by the causal-belief system as well as the statistical cues (Schultz et al. 2007). As with scientists, children have a bias to accept confirmatory evidence, but sufficient counter-evidence will have a role (Legare et al. 2010). Furthermore, use of statistical cues varies depending on one’s understanding of the sampling process (e.g., Was the sample selected randomly or intentionally? Was the sample selected with the goal of learning about the sample or with the goal of teaching about the sample?), and even young children appreciate this (Gweon et al. 2010, Kushnir et al. 2010, Rhodes et al. 2010, Xu & Tenenbaum 2007).

A second argument for the importance of theories in human concepts is that language learning—arguably a hallmark of human cognition—requires theory-rich social understanding (Sabbagh & Baldwin 2005). Thus, one cannot acquire language without a capacity to read others’ intentions (Tomasello 2001), judge a speaker’s credibility (Koenig & Woodward 2010), and distinguish representations from objects represented (Preissler & Carey 2004). Learning words does not simply entail low-level associations between word and referent (Waxman & Gelman 2009); children selectively consider information that supports the model that a speaker is intentionally naming to convey a conventional label. Thus, for example, if the child is attending to one object while the adult labels another, even 16-month-olds will figure out that the label attaches to the object the adult was looking at and not to the focus of the child’s own attention (Baldwin 1993). [It is interesting to note, in this regard, that demonstrations of word learning in nonhuman species, e.g., Kaminski et al. (2004), generally have not examined whether the word-learning process is similar to that of human children, i.e., whether it is tied to these social capacities (Markman & Abelev 2004).]

A third argument for the centrality of naive theories is that attention to causal structure and nonobvious constructs is apparent early in ontogeny. Young children actively seek to understand how and why things happen by asking causal questions (Frazier et al. 2009), making predictions (Shultz 1982), engaging in interventions (Kushnir & Gopnik 2005), and providing explanations (Callanan & Oakes 1992, Legare et al. 2010, Wellman et al. 1997). Even preverbal infants hold firm expectations regarding causal processes (Baillargeon 2002, Cohen & Oakes 1993, Gopnik & Wellman 1994, Leslie 1994). Young children also consider nonobvious, invisible, theorized constructs such as mental states (Wellman 2010), ontological distinctions (Booth et al. 2005), function (Asher & Kemler-Nelson 2008), internal parts (Diesendruck 2001), essences (Gelman 2003), and abstract kinds (Brandone et al. 2011).

The centrality of causation in cognition can be seen in both predictions and explanations (Keil 2006). Interestingly, the process of explaining may alter our cognitive representations and constitute a mechanism for learning...
(Chi et al. 1994, Lombrozo 2006, Siegler 2002, Wellman & Liu 2007). Children can be more accurate when explaining than when predicting (Legare et al. 2009). They also learn more when they are asked to explain events than when they are only given feedback about the accuracy of their predictions (Amsterlaw & Wellman 2006). At the same time, both adults and especially children overestimate the detail and depth of their explanatory knowledge (Keil 2003, Mills & Keil 2004) (Figure 1).

Thus, explanation has a central yet inconsistent role: On the one hand, people actively seek explanations. Yet, on the other hand, they are poor at assessing their own causal knowledge, leading them to believe that they understand things when they do not. This seeming paradox raises the question of what motivates the explanatory process. Why seek explanations if you (incorrectly) think you already possess a deep causal understanding? A key factor turns out to be inconsistency: Learners are especially motivated to construct an explanation when there is an inconsistency to be reconciled or a problem to be solved (Legare et al. 2010). Specifically, inconsistencies prompt exploratory, hypothesis-testing behavior. Research with preschool children has examined the relationship between explanation and exploratory behavior following consistent versus inconsistent outcomes. For inconsistent outcomes only, the kind of explanation children provide informs the kind of exploratory behavior they engage in, as well as the extent to which children modify and generate new hypotheses (Legare 2011). Importantly, exploratory behavior does not exclusively reflect children’s explanatory hypotheses; instead, causal explanation and exploratory behavior likely operate in tandem as hypothesis-generating and hypothesis-testing mechanisms. As Karmiloff et al. (1978, p. 207) note, “action sequences are not merely a reflection of the child’s implicit theories. The very organization and reorganization of the actions themselves, the lengthening of their sequences, their repetition and generalized application to new situations give rise to discoveries that will regulate the theories, just as the theories have a regulating effect on the action sequences.”

Although causal understanding can be understood in general terms, theories are by their very nature domain-specific. We turn next to an examination of intuitive theories in two domains: psychology (minds) and biology (living things).

**Theory of Mind**

Core theories emerge early in childhood, persist across widely varying cultural contexts, and concern (evolutionarily) privileged domains of human cognition (Wellman & Gelman 1998). Perhaps the most thoroughly studied intuitive theory is that known as theory of mind—the ontological, causal beliefs we have regarding the motivations, goals, intentions, and consequences of human behavior. As many have observed (e.g., Wellman 2010), humans do not think about actions in terms of overt behaviors alone (indeed, doing so would result in profound difficulties in navigating the social world), but rather in terms of unobserved (theorized) mental constructs: beliefs, desires, intentions, goals. The ability to relate the simple action sequences produced by perceptual cues to the cognitive beliefs of a perceived actor facilitates the emergence of more complex representations of intention and, in turn, the ability to reason about future behavior.

Among the exciting discoveries of cognitive science in the past two decades is the richness of the human capacity to engage in “mind-reading” (for a review, see Wellman 2010). From birth, infants prefer to look at faces (Johnson 1992), to attend to voices (Vouloumanos & Werker 2007), and to imitate conspecifics (Meltzoff 2005). Within the first year of life, infants appreciate goal-directed action as distinct from mere movement [e.g., when viewing a hand reaching toward object A at location X, 5-month-old infants interpret the action as a reach toward A, not a movement toward X; in contrast, an inanimate stick making the same motion is interpreted as a movement toward X (Woodward 2009)]. By 11–12 months
of age, infants point to direct others’ attention (Bates et al. 1975, Tomasello et al. 2007), monitor others’ gaze (Moll & Tomasello 2004), and engage in social referencing [e.g., to avoid going over a visual cliff if the parent indicates fear (Feinman 1992)]. They learn differently from contexts in which the adult first engages their attention, signaling that the context is a pedagogical one (Csibra & Gergely 2009). At 9–18 months, infants distinguish when someone is unwilling to hand over a toy from when she is unable to do so (Behne et al. 2005). By 18 months, children imitate intended actions rather than observed actions [e.g., when watching someone who attempts to pull apart a toy but fails to do so, the child imitates the (unfulfilled) goal action, whereas virtually no imitation takes place when the same action is demonstrated by a machine (Meltzoff 1995)]. During the second year of life, children show a propensity to share, cooperate, and distribute resources equitably and even engage in altruistic action (Warneken & Tomasello 2009). All these capacities provide an important foundation for social interchanges and an ability to learn from others.

At the same time, there are striking developmental changes in young children’s theory of mind. From 3 to 5 years of age, children undergo dramatic improvement in their ability to reason about false beliefs (e.g., believing that a toy is hidden in the closet when it is actually under the bed). In classic tests of false belief, 3-year-olds show a reality bias, for example, reporting that someone who was not watching when the toy was moved from the closet to under the bed nonetheless will believe it to be under the bed and will search there when given an opportunity (Perner et al. 1987). By 5 years of age, children generally pass this test, indicating a capacity to hold in mind alternative mental construals. Along with the capacity to reason about false belief comes an ability to reason about deception. Whereas 3-year-olds have great difficulty understanding deception, 5-year-olds become able to deploy it appropriately as needed (Talwar & Lee 2008). Individuals with autism spectrum disorder continue to fail tasks of false belief, thus permitting a revealing contrast of what a theory of mind entails. A further complication to this developmental story is that infants seem to appreciate false belief when assessed using measures of looking time (Kovács et al. 2010, Onishi & Baillargeon 2005). Although there is lively debate to explain the discrepancy between traditional measures with preschoolers and looking-time measures with infants, one possibility is that implicit sensitivity emerges before explicit awareness (for an example of implicit awareness preceding explicit performance when reasoning about gravity, see also Hood et al. 2000).

Another thriving controversy concerns how much of theory of mind is exclusively human (Call & Tomasello 2008, Povinelli & Vonk 2003). Tomasello (2009) makes a thought-provoking distinction between cooperation and competition. Chimpanzees are amazingly skilled at taking into account others’ perspectives when engaged in competitive action, yet they are much less skilled than are human children in cooperating with others and do not seem to engage in altruism or collaboration as do even young humans (Tomasello 2009). Tomasello has proposed that the human propensity to cooperate leads to pedagogy and imitation to indicate group membership and ultimately to a “cultural ratcheting” effect whereby human artifacts and cultural practices become increasingly complex over time.

Another important comparative example concerns the basis and extent of learning from others. For example, whereas humans reproduce the particular actions used by a model (imitation), chimpanzees reproduce only the outcomes (emulation) (Tennie et al. 2006). The human capacity to learn from others facilitates development at both the individual and cultural level (Tomasello 2008; but see Whiten et al. 2007, for evidence of cultural transmission in chimpanzees). This ability helps children to become socialized, permits culture to be transmitted across generations, and underlies progress in science and technology. However, in certain key contexts, it also leads to a fascinating reversal whereby chimps outperform humans.
Specifically, children will reproduce actions that are clearly irrelevant to the functioning of an object (known as overimitation), whereas chimpanzees appropriately limit their actions to those that are functionally relevant (Lyons et al. 2007, Want & Harris 2002, Whiten et al. 2009).

Some have suggested that overimitation is a foundation for ritual action. Given that humans are inveterate “mind-readers” (forever wondering what intentions motivate the behavior of others), it is of particular interest that rituals, unlike much of intentional action, do not appear to be motivated by individual goals or belief states. Indeed, ritualized actions pose a unique challenge to theoretical accounts of teleological and causal reasoning because they are irreducible to any set of intentional meanings (Humphrey & Laidlaw 1994), technical/functional analysis, or causal motivations (Bloch 2004, Sperber 1975, Whitehouse 2004). Learning a technical procedure requires an understanding of both ultimate intentions and the proximate intentions that lie behind sequential chains of action-units. However, in ritual actions, proximate and ultimate intentions are decoupled (Sorensen 2007).

Decoupling representations of proximate and ultimate intention is essential because it undergirds the key difference between imitative and emulative behavior. Gergely et al. (2002) further note that emulative teleological learning operates according to the principle of rational action, where even the proximate intentions associated with action-units are causally linked to the pursuit of a particular ultimate intention, whereas imitative learning entails teleologically opaque or “ritualized” procedural sequences in which a string of actions and the proximate intentions necessary to generate them are not causally linked to the pursuit of a given ultimate intention (Legare & Whitehouse 2011). In a series of experiments, Gergely et al. (2002) documented an early emerging bias toward imitative learning (“copying” of chunks of behavior) when pedagogical cues are present and emulative learning (based on reconstructing the causal relationship between actions and intended outcomes) when such cues are unavailable (see also Southgate et al. 2009). Some experimental evidence suggests that ostensive cuing implicitly triggers in infants as young as 8 months expectations that the information imparted will be useful in future situations (Csibra & Gergely 2009). One possibility is that all ostensively cued behavior is assumed by default to have a physical-causal rationale, known to somebody if not to oneself (Lyons et al. 2007). Another possibility is that such behavior is assumed by default to be a matter of stipulation and convention, carrying normative force. For example, 3-year-olds and, to a lesser degree, even younger children show strong reactions (e.g., protest, corrections) to violations of newly learned arbitrary rules (Rakoczy et al. 2008). This intriguing research suggests that the capacity to take an imitative “ritual stance” appears very early in development (Legare & Whitehouse 2011).

Theory of Living Kinds

The importance of domain-specific theories can also be seen in how people reason about the biological world. One striking aspect of human concepts of living things is that they are organized into multilevel hierarchical inclusion systems (e.g., white-crowned sparrows < sparrows < birds < animals), where a “basic” or middle level of abstraction (e.g., either birds or sparrows, depending on one’s level of expertise) (Tanaka & Taylor 1991) is accessed most quickly on a range of cognitive tasks (Rosch 1978). These taxonomies are found broadly across different communities and contexts (Berlin et al. 1973), and basic-level categories serve as the basis for generalizing knowledge [e.g., after learning a new fact about a blackbird, children and adults are more likely to generalize that fact to a flamingo (another, dissimilar bird) than to a bat (a similar nonbird) (Gelman & Markman 1986)].

The extent to which concepts of living things can be considered biological, however, depends on age, cultural context, and instruction. As with theory of mind, we see both early sensitivity and extensive conceptual change.
Even infants distinguish animate patterns of motion from inanimate patterns of motion on the basis of perceptual cues from point-light displays (Bertenthal et al. 1985), anticipate different causal consequences when animate versus inanimate objects collide (Spelke et al. 1995), and expect animate objects—but not inanimate objects—to move directly toward goals (Opfer & Gelman 2010, Rakison et al. 2007). By preschool age, young children believe that living things engage in distinctively self-generated and regular patterns of behavior and growth (Barrett et al. 2005, Bulloch & Opfer 2009, Inagaki & Hatano 2002, Massey & Gelman 1988, Opfer 2002, Rosengren et al. 1991). They treat membership in an animal category as absolute, and distinctions between different animal species as natural and objective, whereas they view distinctions between different artifact species as conventional and subjective (Rhodes & Gelman 2009a,b).

Yet there is also massive conceptual change regarding the classification of biological items: It can take children years to sort out which things are alive (Carey 1985) or to appreciate that humans are one kind of animal among many (Johnson et al. 1992). At the same time, beliefs concerning basic biological concepts, including mechanisms of biological transmission (e.g., inheritance, ingestion), vary widely as a function of cultural input and instruction (e.g., Au et al. 2008, Herrmann et al. 2010, Medin et al. 2010).

Contamination and illness are particularly informative for exploring children’s causal understandings, because biological reasoning often requires the recruitment of unobservable entities and processes (such as germs or toxins) to predict and explain more overt phenomena (Legare et al. 2009). A lay understanding of contamination exemplifies this sort of reasoning: Adults report that contact with a contaminating substance causes food or beverages to become undesirable and offensive (Rozin & Fallon 1987), even if the contaminating substance is not toxic and leaves only an imperceptible physical or symbolic trace. Thus, contamination provides a forum in which children can potentially provide rich biological explanations based on unobservable as well as observable causal factors. Furthermore, naive biological reasoning about contamination provides a fruitful domain for exploring cultural differences. Although the specific kind of substance, process, or contact considered contaminating varies across different cultural contexts (Stigler et al. 1990), sensitivity to contamination is likely universal (Hejmadi et al. 2004, Raman & Gelman 2004, Rozin et al. 1985). Similarly, illness is a human universal, although the ways in which particular cultural communities explain, treat, and prevent ill health is deeply shaped by their worldview, particular belief systems, and valued cultural activities (Inagaki & Hatano 2002, Rozin 1996).

One open question is whether there are certain modes of thought that are used preferentially when reasoning about biological concepts (Keil 1995). Two that have been proposed are psychological essentialism and teleological thinking.

**Psychological Essentialism**

Psychological essentialism is an implicit belief that members of a category share deep commonalities that make them what they are (Ahn et al. 2001, Gelman 2003, Medin 1989). In other words, categories have a deeper reality underlying manifest appearances. Thus, although birds vary widely in size, behavior, habitat (consider hummingbirds, dodos, penguins, and vultures), they all share an underlying “bird essence.” Essentialist accounts have been offered, in one form or another, for thousands of years, extending back at least to Aristotle and Plato. Research with young children suggests that essentialism is an early cognitive bias, as young children’s concepts reflect a deep commitment to essentialism. Children look beyond the obvious in many converging ways: when learning words, generalizing knowledge to new category members, reasoning about the insides of things, contemplating the role of nature versus nurture, and constructing causal explanations (Gelman 2003). For example, when...
asked to consider a newborn calf that is raised exclusively with pigs, young children predict that it will grow up to moo (not oink) and have a straight (not curly) tail—in other words, that nature will overcome nurture (Gelman & Wellman 1991). These findings argue against the classic view of children as concrete or focused on the obvious (Piaget 1928), instead claiming that children have an early, powerful tendency to search for hidden, nonobvious features of things. For cross-cultural evidence for essentialism, see Astuti et al. (2004), Atran et al. (2001), Diesendruck (2001), Gil-White (2001), Sousa et al. (2002), and Waxman et al. (2007).

Some have suggested that psychological essentialism is rooted in an intuitive biological understanding (Atran 1998, Boyer 2001). On this view, just as humans universally construct basic-level categories and taxonomies, so too do they honor the principle that dissimilar items are deeply alike and can share a name. However, psychological essentialism appears to be a more general way of thinking that transcends domains (Bloom 2000, Gelman & Hirschfeld 1999). For example, essentialist beliefs extend to reasoning about individuals (e.g., Bob and Joe have distinct and unique souls) (Gottfried et al. 1999) and social categories such as race or gender (Birnbaum et al. 2010, Diesendruck & haLevi 2006, Hirschfeld 1996, Rhodes & Gelman 2009a, Rothbart & Taylor 1992). Essentialism also appears to be a framework for thinking about artifacts, in that everyday objects can be construed as containing hidden, causally powerful properties: For example, people refuse to wear a sweater once owned by Hitler (Nemeroff & Rozin 1994) or they pay vast sums for Neil Armstrong’s autograph or a Picasso original (Bloom 1996). Children, too, place special value on objects with strong emotional histories (Frazier et al. 2009, Frazier & Gelman 2009, Gelman & Frazier 2007, Hood & Bloom 2008). Even humble artifacts (an ordinary spoon) can be thought of in terms of an essence, namely, the intent of the creator can be decisive in determining category membership (Gelman & Bloom 2000). An open question is whether psychological essentialism starts out specifically within the biological domain and then spreads, or whether it is a more domain-general phenomenon from the start (Gelman 2003).

Teleological Reasoning

Teleological reasoning involves seeing entities or parts of entities as existing for a purpose. For example, the handle of a teacup exists for the purpose of allowing people to hold a hot cup without burning their fingers; a giraffe has a long neck so that it can eat leaves off tall trees. An ongoing debate concerns whether this tendency to seek purpose in the world around us is specific to certain domains, such as biological kinds and human-made artifacts (Keil 1992), or instead reflects a broad teleological tendency (Kelemen 1999). On a range of tasks, children engage in “promiscuous teleology” (reporting that clouds are made for raining, or lions are made for going in a zoo), and adults tend to fall back on teleological explanations when placed under timing constraints and forced to answer quickly (Kelemen & Rosset 2009). Kelemen suggests that children may extend this tendency to reason about existential questions, such as the origins of life, and ultimately results in an intuitive theology (assuming that everything has a designer and a purpose).

Both psychological essentialism and teleological reasoning create problems for learning scientific concepts. In particular, there is extensive resistance to evolutionary theory (upwards of 50% of the population in the United States reject evolutionary theory), and conceptual biases—including essentialism and promiscuous teleology—play an important role (Gelman 2003, Kelemen 2004, Mayr 1982, Shutman & Schulz 2008, Sinatra et al. 2008). Gelman & Rhodes (2011) suggest that essentialism poses five obstacles to a theory of evolution:

1. Essentialism assumes that categories are stable and immutable, which competes with the view from natural selection that species can change over generations.
2. Essentialism posits that category boundaries are relatively strict and impermeable, thus leading to a rejection of categories that cross strict boundaries.

3. Essentialism leads to an underestimation of category variability, or treating variability as “noise,” thereby leading to difficulty accepting the core factual basis for evolution.

4. Essentialism assumes that causes inhere in the individual, leading to difficulty appreciating population-level causal forces (which are at play during evolution).

5. Finally, the Platonic notion of category ideals encourages the view of evolution as progressive (with species always improving), which mischaracterizes the nature of evolutionary change.

When Theories Collide: Do Explanatory Frameworks Coexist or Compete?

Commonsense theories provide broad frameworks that attempt to uncover underlying explanatory principles to account for complex phenomena. Although much research has focused on causal explanatory reasoning in scientific domains (see previous sections), until recently there has been much less psychological research on how people think about magical or divine powers (but see Astuti & Harris 2008, Barrett et al. 2001, Boyer & Walker 2000, Legare & Gelman 2008, Whitehouse & McCauley 2005, Rosengren et al. 2000, Woolley 2000). Given the potential for shared objectives of science and religion—to enable us to explain, understand, and intervene in the world—there is much to be gained by investigating the extent to which a single cognitive system accommodates both kinds of thinking, even with respect to the same phenomena.

Although access to multiple kinds of explanatory systems is a universal psychological experience, little is known about how children and adults respond to distinct explanatory accounts of the world, how such beliefs codevelop, or the extent to which people accommodate diverse explanatory frameworks to explain the same events. In both lay and scientific writing, scientific explanations and religious explanations are often presented as competing or incompatible (Bloom 1992, Dawkins 2006, Preston & Epley 2009). The assumption that scientific explanations may eventually prevail owing to their superiority at providing empirically testable explanations is consistent with the secularization hypothesis, which states that as science and technology advance they will increasingly displace religious explanations (Norris & Inglehart 2004). An alternative to this displacement account is that scientific and religious explanations do not overlap because they serve different objectives or are used to explain different types of events (Biema 2006, Gould 1997).

Contrary to claims of displacement, we argue that the commonly held assumption that science and religion offer incompatible, competing frameworks is inaccurate at the psychological level. New cognitive developmental research from a variety of different cultural contexts indicates that these two explanatory frameworks often coexist within the same individual, even with respect to the same to-be-explained phenomenon. Coexistence holds across both development and diverse cultural contexts (Astuti et al. 2004, Evans et al. 2011, Raman & Gelman 2004).

Table 1 presents examples of coexistence thinking across three domains of biological thought. For example, with regard to human origins, Americans and Europeans are exposed both to a creationist explanation (i.e., God placed humans on earth) and an evolutionary explanation (i.e., humans evolved from different kinds of living things) (Evans 2001). Similarly, both biological and nonbiological explanations for the transmission and cure of serious illnesses are prevalent cross-culturally. For instance, although information about the transmission of the AIDS virus is widely available via health and education programs (Legare & Gelman 2009), accounts of infection based on witchcraft are promulgated (Ashforth 2001, Farmer 1999, Legare & Gelman 2008). Finally, although
all people are confronted by the biological inevitability and finality of death, in many religious traditions they are also exposed to afterlife beliefs (Astuti & Harris 2008, Harris & Giménez 2005, Talwar et al. 2011). Positing coexistence contrasts with long traditions of theory and research in developmental and cultural psychology. In developmental psychology, it has been claimed that young children gradually abandon a belief in magical causation and instead acquire a more objective, rational, or scientific appreciation of the world around them (Harris 2009, Piaget 1928). Likewise, in cultural psychology, research has shown that education and modernization accelerate various aspects of cognitive development (Cole 2005, Gauvain & Munroe 2009, Luria 1976, Vygotsky 1978). Thus research in each of these disciplines is consistent with the possibility that, over the course of history, with more widespread access to education and modernization, a focus on scientific explanations will increasingly compete with, and even displace, nonscientific explanations. However, relatively few adults, across a wide range of cultural backgrounds, endorse exclusively scientific explanations (Hood 2009, Misztal & Shupe 1992, Raman & Winer 2004, Tambiah 1990). How can the traditional view of cognitive development as the acquisition of more objective,
rational, and scientific thought be reconciled with the fact that religious and magical explanations are present in many cultural contexts and are a pervasive feature of cognition for most adults?

One plausible resolution of this paradox could be that these distinct explanatory frameworks operate differently in different individuals (some individuals are more scientific or religious than others) or at least over different domains or contexts (an individual may hold scientific explanations for certain phenomena and religious explanations for other phenomena). However, multiple explanations frequently operate within the same mind to explain the very same event or phenomenon (Legare et al. 2011, Subbotsky 2001). In fact, in certain domains, the tendency to invoke magical or religious explanations increases rather than decreases with age (Astuti & Harris 2008, Evans 2001, Harris & Giménez 2005, Legare & Gelman 2008, Raman & Gelman 2004). Consistent with sociocultural perspectives (Cole 2005, Greenfield et al. 2006, Rogoff 2003, Vygotsky 1978), we propose that both scientific and nonscientific explanatory systems require considerable cultural experience and participation in dynamic aspects of the social-learning process, whereby children seek and actively construct information in collaboration with others (Callanan 2006).

**Target-Dependent Thinking**

Psychological research on explanatory coexistence suggests that, when considering a single event, individuals recruit multiple explanatory frameworks (Evans et al. 2011). In the case of target-dependent thinking, alternative views of the world are recruited to provide a coherent explanation of a given phenomenon but are used to explain distinct aspects of that phenomenon, depending on the particular kind of causal attribution. For example, in the case of reasoning about the origin of diverse species, an evolutionary framework might be recruited to explain the origin of nonhuman species whereas a theistic framework might be recruited to explain the creation of human beings.

**Synthetic Thinking**

In the case of synthetic thinking, multiple explanations are used to explain the same aspects of a given phenomenon. Such multifaceted explanations may involve a loose integration of distinct frameworks but without any detailed consideration of how they would interact (Vosniadou et al. 2008). For example, when reasoning about death, one may recruit information about both the body and the soul (Harris & Giménez 2005) without specifying the role each plays in the process.

**Integrated Thinking**

In the case of integrated thinking, multiple explanations for a single phenomenon are combined in a more precise and well-coordinated manner. Integration is achieved by using different explanations for different levels of analysis; a scientific cause can be regarded as proximate and a nonscientific cause as ultimate. For example, in the case of serious illness, a biological risk factor may be regarded as a proximate cause, whereas punishment from witchcraft may be regarded as the ultimate cause (Evans-Pritchard 1937, Legare & Gelman 2008).

We argue that religious or magical explanations do not always appear early in development, nor are they primitive or immature ways of thinking that are suppressed over the course of development. Instead, as with biological explanations, they are a pervasive feature of human cognition across the lifespan, are constructed and elaborated through socialization and cultural learning, and may be founded on earlier intuitive explanations.

**SUMMARY AND CONCLUSIONS**

The study of mental content is daunting in light of its seemingly unconstrained variety. However, empirical investigations of the mind reveal systematic patterns in the ways
that humans consider evidence and build knowledge structures. In brief, an examination of mental representations supports three broad conclusions. First, concepts are informed by domain-specific, causal-explanatory theories and are not constructed solely in a bottom-up fashion from perceptual primitives. Second, there are persistent cognitive biases that influence what information we take in and consider. Third, multiple explanatory theories coexist, side-by-side, within an individual. Many questions remain for the future, including those regarding the following: the evolutionary basis of intuitive theories, what sorts of social contexts and cultural practices influence or alter intuitive theories, which conditions foster conceptual variation and conceptual change, how intuitive beliefs relate to explicit cultural stories (for an example of intuitive theories that do not always conform to explicit cultural descriptions, see Astuti et al. 2004), and the influence of particular intuitive theories for human behavior (e.g., effects of theory of mind on cooperative and competitive interactions, effects of psychological essentialism on treatment of social groups). As we attempt to show in this article, developmental evidence from infants and young children can be particularly valuable by revealing the process by which knowledge and beliefs are constructed.

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

ACKNOWLEDGMENTS

The writing of this article was supported by NICHD grant HD-36043 to S.A.G. We thank Bruce Mannheim for helpful comments on an earlier draft.

LITERATURE CITED


Hood B, Carey S, Prasada S. 2000. Predicting the outcomes of physical events: two-year-olds fail to reveal knowledge of solidity and support. *Child Dev.* 71:1540–54


Rakison D, Cicchino J, Hahn E. 2007. Infants’ knowledge of the path that animals take to reach a goal. *Br. J. Dev. Psychol.* 25:461–70


Figure 1
When people estimate how deeply they understand the workings of various systems, they tend to think they know far more depth of detail than they actually do. When asked how a helicopter works, they seem to think they have knowledge approximating a detailed annotated drawing, but they actually have a much coarser understanding corresponding to little more than the sense of a thing with blades that turn and provide lift. This illusion is quite specific to explanatory kinds of knowledge. People estimate the depth of their knowledge of procedures, facts, and narratives much more accurately. From Keil (2003). Adapted with permission from Crown Publishers (Wright & Patel 2000).
Contents

Prefatory Chapter
Anthropological Relocations and the Limits of Design
  *Lucy Suchman* ................................................................. 1

Archaeology
The Archaeology of Consumption
  *Paul R. Mullins* ............................................................ 133

Migration Concepts in Central Eurasian Archaeology
  *Michael D. Frachetti* ...................................................... 195

Archaeologists and Indigenous People: A Maturing Relationship?
  *Tim Murray* ................................................................. 363

Archaeological Ethnography: A Multitemporal Meeting Ground
  for Archaeology and Anthropology
  *Yannis Hamilakis* .......................................................... 399

Archaeologies of Sovereignty
  *Adam T. Smith* .............................................................. 415

A Century of Feasting Studies
  *Brian Hayden and Suzanne Villeneuve* ............................. 433

Biological Anthropology
Menopause, A Biocultural Perspective
  *Melissa K. Melby and Michelle Lampl* ............................. 53

Ethnic Groups as Migrant Groups: Improving Understanding
  of Links Between Ethnicity/Race and Risk of Type 2 Diabetes and
  Associated Conditions
  *Tessa M. Pollard* .......................................................... 145

From Mirror Neurons to Complex Imitation in the Evolution
  of Language and Tool Use
  *Michael A. Arbib* ......................................................... 257
From Hominoid to Hominid Mind: What Changed and Why?
Brian Hare ................................................................. 293

The Human Microbiota as a Marker for Migrations of Individuals
and Populations
Maria Gloria Dominguez-Bello and Martin J. Blaser ......................... 451

**Linguistics and Communicative Practices**

Publics and Politics
Francis Cody ............................................................... 37

Ritual and Oratory Revisited: The Semiotics of Effective Action
Rupert Stasch ............................................................ 159

Language and Migration to the United States
Hilary Parsons Dick ...................................................... 227

The Balkan Languages and Balkan Linguistics
Victor A. Friedman .................................................... 275

**International Anthropology and Regional Studies**

Central Asia in the Post–Cold War World
Morgan Y. Liu ............................................................ 115

The Ethnographic Arriving of Palestine
Khaled Furani and Dan Rabinowitz .................................... 475

**Sociocultural Anthropology**

Substance and Relationality: Blood in Contexts
Janet Carsten .............................................................. 19

Hallucinations and Sensory Overrides
T.M. Luhrmann .......................................................... 71

Phenomenological Approaches in Anthropology
Robert Desjarlais and C. Jason Throop ................................ 87

Migration, Remittances, and Household Strategies
Jeffrey H. Cohen .......................................................... 103

Climate and Culture: Anthropology in the Era of Contemporary
Climate Change
Susan A. Crate ............................................................ 175

Policing Borders, Producing Boundaries. The Governmentality
of Immigration in Dark Times
Didier Fassin .............................................................. 213
# Contents

The Cultural Politics of Nation and Migration  
*Steven Vertovec* ........................................................................................................ 241

Migrations and Schooling  
*Marcelo M. Suárez-Orozco, Tasha Darbes, Sandra Isabel Dias, and Matt Sutin* ...... 311

Tobacco  
*Matthew Kohrman and Peter Benson* ................................................................. 329

Transnational Migration and Global Health: The Production and Management of Risk, Illness, and Access to Care  
*Carolyn Sargent and Stéphanie Larchanche* ...................................................... 345

Concepts and Folk Theories  
*Susan A. Gelman and Cristine H. Legare* .......................................................... 379

Migration–Religion Studies in France: Evolving Toward a Religious Anthropology of Movement  
*Sophie Bava* ........................................................................................................ 493

**Theme I: Anthropology of Mind**

Hallucinations and Sensory Overrides  
*T.M. Luhrmann* .................................................................................................... 71

Phenomenological Approaches in Anthropology  
*Robert Desjarlais and C. Jason Throop* ............................................................ 87

From Mirror Neurons to Complex Imitation in the Evolution of Language and Tool Use  
*Michael A. Arbib* ................................................................................................ 257

From Hominoid to Hominid Mind: What Changed and Why?  
*Brian Hare* ............................................................................................................ 293

Concepts and Folk Theories  
*Susan A. Gelman and Cristine H. Legare* .......................................................... 379

**Theme II: Migration**

Migration, Remittances, and Household Strategies  
*Jeffrey H. Cohen* ................................................................................................. 103

Ethnic Groups as Migrant Groups: Improving Understanding of Links Between Ethnicity/Race and Risk of Type 2 Diabetes and Associated Conditions  
*Tessa M. Pollard* .................................................................................................. 145

Migration Concepts in Central Eurasian Archaeology  
*Michael D. Frachetti* .......................................................................................... 195
Policing Borders, Producing Boundaries. The Governmentality of Immigration in Dark Times

Didier Fassin ................................................................. 213

Language and Migration to the United States

Hilary Parsons Dick ......................................................... 227

The Cultural Politics of Nation and Migration

Steven Vertovec ............................................................. 241

Migrations and Schooling

Marcelo M. Suárez-Orozco, Tasba Darbes, Sandra Isabel Dias, and Matt Sutin .................................................. 311

Transnational Migration and Global Health: The Production and Management of Risk, Illness, and Access to Care

Carolyn Sargent and Stéphanie Larchanché ................................................. 345

The Human Microbiota as a Marker for Migrations of Individuals and Populations

Maria Gloria Dominguez-Bello and Martin J. Blaser ........................................... 451

Migration-Religion Studies in France: Evolving Toward a Religious Anthropology of Movement

Sophie Bava ................................................................. 493

Indexes

Cumulative Index of Contributing Authors, Volumes 31–40 .................. 509
Cumulative Index of Chapter Titles, Volumes 31–40 ................................. 512

Errata

An online log of corrections to Annual Review of Anthropology articles may be found at http://anthro.annualreviews.org/errata.shtml