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Intuitive Theories

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Intuitive theories refer to informal, and usually incomplete, understandings of distinct domains. They arise in the absence of explicit instruction and reflect people's naturally emerging accounts of why things occur or how things work. They have multiple elements, often described as concepts. These elements have some degree of relational coherence, which, in turn, describe regularities. Within this broad characterization, several variants have been described, most notably innate or very early emerging interpretative biases (e.g., theories of physical mechanics and goal-directed agents), explanatory models of phenomena that can appear at any point in life without input from others (e.g., intuitive theories of economics), and interpretative accounts of reality that may arise in a group with no relevant experts (e.g., shared intuitive beliefs about how a medicine works). Although they are often described as occurring outside of awareness and as the basis for unwitting biases and errors, individuals can also be partially or fully aware of their intuitive theories. Some intuitive theories are thought to be universal cognitive tools common to all minds, whereas others may vary across individuals and communities. For the most part, intuitive theories capture aspects of causal relations. In formal disciplines such as mathematics, intuitive theories can be completely acausal, but almost all cognitive science examples involve some degree of causal interpretation. Intuitive theories have proven to be foundational representational components in many areas of cognitive science, ranging from categorization to argumentation.

History

Some of the first proposals of intuitive theories in the cognitive sciences involved theories about the mental states of agents. [Premack and Woodruff \(1978\)](#) proposed theories of mind in humans and other primates. An earlier version was described by [Heider \(1958\)](#) as a *naive psychology*. Heider was influenced by a human tendency to promiscuously construe cause and effect relations in psychological terms. Thus, adults attributed psychological causality, such as chasing and being afraid, to the interactions of simple geometric figures in videos ([Heider & Simmel, 1944](#)). Heider's approach had a distinctly cognitive science flavor. He was interested in a general intuitive theory of mind and in formulating principles that govern how humans make inferences about others' mental states and processes ([Malle, 2008](#)).

Across domains as diverse as physics and psychology, intuitive theories have frequently been described as informal versions of academic disciplines. The overlaps with formal disciplines, however, are invariably only approximate because they often contain major omissions. Thus, intuitive physics is normally restricted to physical mechanics, whereas the formal science of physics contains many more topics, such as electromagnetism and quantum mechanics.

A key feature of early proposals was the idea that intuitive theories contained distortions about reality. This was especially vivid in the case of physics, where laypeople seemed to be employing a version of Aristotelian impetus theory ([McCloskey, 1983](#); [McCloskey et al., 1980](#)). For example, they appeared to understand trajectories as intrinsic to objects. Thus, objects contained forces that gradually decayed over time after an event such as a collision. In contrast, Newtonian physics focused on universal laws of

motion in which external forces acted on objects. Intuitive theories almost invariably avoided mathematical representations of any complexity or precision, although mathematical formulas are at the heart of many natural sciences and some social sciences, such as economics. Other broad domains include intuitive biology ([Hatano & Inagaki, 1994](#)), sociology ([Shutts & Kalish, 2021](#)), and economics ([Boyer & Petersen, 2018](#)).

Some aspects of intuitive theories can be seen in earlier discussions of the mind. Aristotle and Plato, for example, both attempted to explain the success of human premonitions from dreams in terms of distinctively human implicit intuitions about the world ([Struck, 2016](#)). Other precursors to current accounts of intuitive theories include studies on misconceptions held by children and adults (e.g., [Piaget, 1929](#); [Hall, 1891](#)), but the idea of a systematically related set of beliefs that collectively guided interpretation and prediction, usually with distortions of reality, did not become a central theme in the cognitive sciences until the early 1980s. A second precedent was the characterization of nativist views of language in terms of children having intuitive theories of grammar ([Chomsky, 1965, 1975](#); [Gleitman et al., 1977](#)) [see [Language Acquisition](#)]. Although grammatical intuitions have been connected to intuitive theories in formal computational approaches ([Tenenbaum et al., 2007](#)), such comparisons are less common in more qualitative accounts.

Over the succeeding years, the phrase *intuitive theory* has referred to domains varying greatly in scope. Sometimes it has referred to domains at the scale of academic departments. Other times, intuitive theories have covered narrower areas such as diseases, celestial bodies, and etiquette. Some accounts have focused on early emerging and potentially innate theories, and others have emphasized theories acquired through extensive learning.

Core concepts

Despite the many different types of intuitive theories, certain key concepts emerge across cases.

Domain specificity

Intuitive theories are limited in scope and cover specific domains. Although, in principle, one could have a single intuitive *theory of everything*, the idea of explaining all possible patterns in terms of just one all-encompassing intuitive model has not gained much traction in cognitive science. Characterizing what it means to be a domain, however, can be challenging. One view equates domains roughly with ontological categories (i.e., fundamental categories of existence), where patterns of language use highlight them as a distinct high level of categories. Only certain subsets of all predicates are applicable to an ontological category regardless of whether statements involving those statements are true or false ([Sommers, 1963](#)). For example, the predicate “weighs one pound,” can apply to all physical objects and nothing else. Ideas and events are neither heavy nor light. Thus, some approaches restrict the use of domains to a small set of high-level categories such as physical objects, events, psychological states, and living kinds. However, the sizes of domains have come to vary greatly across the cognitive sciences. Some

approaches suggest categories resembling the departments in a 1950s university but with a bias toward natural and social sciences. Thus, intuitive theories have been described in areas corresponding to physics, chemistry, biology, astronomy (cosmology), psychology, economics, linguistics, sociology, and political science. But reference to academic disciplines is a rough heuristic that quickly breaks down in the more modern university and as the humanities and engineering are included. No studies come readily to mind focusing on intuitive theories of domains such as art history, comparative literature, and electrical engineering.

Another tradition, however, sees no obvious lower bounds to domains. Intuitive theories have been proposed for local phenomena such as object stacking and stability in physics (e.g., [Zhou et al., 2023](#)). Even narrower ranges of intuitive theories include disease contagion, politics, and academic performance (e.g., [Au et al., 1993](#); [DeScioli & Bokemper, 2019](#); [Muradoglu & Cimpian, 2020](#)). In such cases, any relatively contained body of knowledge, or skill, may be a potential candidate for intuitive theory status. Given the centrality of domain specificity in all approaches to intuitive theories, there is a constant need to clearly define and justify the size of domain intended.

Involve causal relations

Although theories in formal domains such as logic and grammar (and some theories in physics) do not involve causality, intuitive theories almost always do. For example, intuitive psychology typically contains the reciprocal notions that desires can cause beliefs and that beliefs can cause desires, and intuitive physics contains the notions that objects support other objects and that pushing an object causes it to move. Not all relations in a causal domain need be causal. For example, intuitive physics may contain the idea that objects must maintain spatiotemporal continuity (non-causal), but causality is often seen as a “glue” that binds elements together. For natural kinds, causal homeostasis has been suggested as the reason why causality is so central ([Boyd, 1999](#)). Thus, a relatively distinct bundle of interacting causal relations maintains the integrity of members of a kind over time and space and keeps them more similar to each other than to other kinds [see [Causal Learning](#)].

Coherence

Intuitive theories must have some degree of coherence. Each of the elements that make up theories need to *cohere* with others and cannot simply be an unrelated list of elements. Coherence therefore assumes that intuitive theories must have some degree of internal consistency. Causal coherence implies causal relations that fit together sensibly and tend to imply each other. Thus, even though a set of causal relations might neatly pick out a domain of things, if they are unrelated to each other, they do not compose a theory. For example, “chases squirrels, licks human faces, and chews on bones...” does not constitute an intuitive theory of dogs. In contrast, “dogs are predatory animals who are descended from wolves and domesticated by humans. By virtue of that history they are...” does constitute a theory. A related concept to coherence is relevance. The elements of a theory should be relevant to the goals of the theory, such as to explain or predict. Incidental information should not be present.

Typically invoke mechanisms or functions

When considered as representing causal relations, intuitive theories typically invoke either mechanisms, functions, or both. Examples of purely functional intuitive theories would be “fertilizer is put on crops to make the crops grow better” and “the accelerator in a car is meant to make the car go faster when it is pressed.” Examples of purely mechanistic intuitive theories would be “a cylinder lock opens by pushing up a series of pins into a line that just clears the cylinder thereby allowing it to rotate...” and “mousetraps are triggered by a pressure sensitive plate that releases a metal rod. The rod in turn releases a strong loaded bar that the spring pushes rapidly down on a location near the plate...” In most cases, functional and mechanistic components interact in nested hierarchical structures that help create coherence ([Craver & Tabery, 2015](#)).

Make ontological commitments

All theories, intuitive or otherwise, make ontological commitments; they assume certain fundamental categories that must exist for the theory to be true ([Quine, 1948](#)). Ontological commitments follow from the domain specificity of theories. Each intuitive theory covers a restricted range of entities and relations ([Chi, 1992](#)). Thus, intuitive psychology commits to the categories of beliefs and desires, whereas physical mechanics commits to bounded solid objects. These assumptions need not be correct in either formal theories (e.g., phlogiston, luminiferous ether) or in intuitive ones (e.g., *circular momentum*). Moreover, the ontological commitments may not fully define the relevant domain. Intuitive theories about dogs and cats would seem likely to make the same ontological commitments but might be seen as distinct intuitive theories.

Contain concepts

Most views of intuitive theories assume they involve structured relations among concepts. Thus, ontological commitments are assumed to result in internal mental representations that enable categorization and inference, which are both functions of concepts. Another major perspective in cognitive science, however, sees concepts themselves as deriving their meanings from how they are embedded in specific theories (e.g., [Murphy & Medin, 1985](#)). This view of concepts is in tension with views of stand-alone concepts as the building blocks of theories. One way to resolve this tension is to assume concepts initially exist as stand-alone, relatively autonomous entities arising from such routes as statistical learning. They then become influenced by other concepts as they are absorbed in a relational theory-dependent structure. Other views see concepts as always depending on their embedding in intuitive theory webs that contain other concepts and never existing as isolated entities [see [Concepts](#)].

Incompleteness

Intuitive theories, especially of broad domains, are incomplete or partial. Thus, intuitive theories of physics do not usually include information about precession effects, and intuitive biology does not usually contain information about inflammation. Versions of intuitive theories that cover limited

domains, such as candles, may seem more complete, but even in such small domains, people often do not realize the massive gaps in their own theories ([Rozenblit & Keil, 2002](#)). Theories are also incomplete with respect to levels of explanation (see [Levels](#)). Finally, intuitive theories can exclude bounded sets of phenomena that are not compatible with how the theory captures other aspects of a domain. For example, intuitive theories of cosmology do not include the notion of dark energy even though it is fundamental to formal theories of the cosmos. Incompleteness can raise questions about the value of intuitive theories when they are so fragmentary and have large gaps. What cognitive support could intuitive theories provide if they are missing so many details? They might still be effective pointers to relevant experts and, at a highly abstract level, provide clues for how to identify legitimate experts.

Levels

Intuitive theories tend to operate at a specific level of reality. They recognize the existence of other levels but need not rely on those other levels. An intuitive biology may be at the level of “functions of animal organs” while vaguely acknowledging a lower level of microstructural processes that account for the properties of those organs and a higher level involving ecosystems. People rarely go beyond mere acknowledgement of distinct levels and prefer to employ intuitive theories at the same level of explanation. They avoid repeatedly hopping between levels ([Johnson & Keil, 2014](#)).

Support explanation and prediction

People rely on intuitive theories to help provide explanations and predictions. Naive theories of disease transmission are used to explain incidents of illness and to guide behaviors intended to avoid a future disease. In many cases, both explanations and predictions can be wrong. Intuitive theories are also invoked to explain past events while not making future predictions. A family might explain at length the last words of a dying relative with no obvious implications for future predictions. Similarly, in more formal sciences, a fossil record shift might be explained to make sense of a one-time ancient event while making no predictions about future fossil patterns. Recently, a new tension is emerging between prediction and explanation in which explanations are discounted and predictions alone are favored (see [Questions, controversies, and new developments](#)).

Distortions and illusions

Virtually all intuitive theories are portrayed as distorting reality in some way. Given that most formal scientific theories are also assumed to distort through idealization and abstraction, distortions in intuitive theories are hardly surprising. Distortions can range from assumptions of nonexistent entities to incorrect assumptions about behaviors, such as assuming linear processes instead of exponential ones. They can also distort more in some domains than others (e.g., essentialist biases are stronger in natural kind domains than in artifact domains) or in a more domain-general manner, such as with base-rate neglect. The presence of distortions, in combination with incompleteness, provides reasons why several distinct intuitive theories might be fruitfully applied to the same phenomena. Each one may provide unique distortions but also unique insights that together allow us to understand phenomena more fully.

Resistance to competing theories

Intuitive theories have commonly been assumed to resist acceptance of competing theories or information that does not fit with one's own theory. Such effects have been stressed in many developmental accounts where it is argued that early intuitive theories endure into adulthood with a kind of robustness and immediacy that can hinder reasoning about scientific theories (e.g., [Shtulman, 2017](#)). For example, earth-centered intuitive theories of cosmology can cause even professional astronomers to take longer to verify statements where intuitive theories and formal scientific knowledge of orbital patterns conflict. Intuitive theories can also conflict in different ways. Some pose clashes in associative strengths for intuitive theory features. Others pose clashes in what are considered an intuitive theory's critical causal relations ([Shtulman & Legare, 2020](#)).

Coexistence of competing intuitive theories

In addition to the notable cases described above of conflicting intuitive theories that interfere with each other, intuitive theories can also peacefully coexist even though they clearly contradict each other. For example, many people have intuitive theories of biological kinds as having essences (perhaps as a specific gene sequence) while also having intuitive theories of the evolution of species through natural selection. Until they are asked to think through the two theories side by side, they may not realize that they cannot both be true. Natural selection critically relies on a distribution of similar genetic sequences in members of a species. If all members had identical DNA, there would be no variation in genotypes and phenotypes on which natural selection could work. Conflicting theories of this sort presumably persevere because they are more useful in reasoning about certain problems than they are a hindrance in their areas of conflict. People may also be aware of conflicts but keep both theories because each provides unique valuable insights.

Questions, controversies, and new developments

What intuitive theories are innate?

Perhaps the most contested debate about intuitive theories is the extent to which certain ones, if any, are innate. Innateness is attractive in those cases where abilities emerge early and domain specificity is clear cut ([Margolis & Laurence, 2023](#)). Yet, as claims about the power of early human learning systems are expanded and are buttressed by analogies to recent leaps in deep learning, more proposals are emerging for *minimal nativism* ([Ullman & Tenenbaum, 2020](#)). Minimal nativists argue that researchers have historically underestimated the power of domain-general learning capacities and the extent to which these capacities can create domain-specific intuitive theories. They acknowledge the probable need for some small innate primitives for broad domains such as physics to get learning off the ground in those domains but see the goal as one of paring down those sets of primitives to the smallest possible number for each domain. Although minimal nativism is a useful perspective, it is not clear why this should be the default. A different approach might favor *maximal nativism*. Maximal nativism seeks to prepare humans with the most robust head starts in each domain by building in as much as possible while still allowing

for the flexibility needed to learn novel patterns. If a large set of physical regularities is rarely violated, then maximal nativism seeks to endow neonates with a rich set of primitives in the domain of physical objects that are tuned to those regularities. Those primitives might give the infant a survival advantage in avoiding physical threats while also freeing up computational space for those novel patterns that must be learned through more domain-general learning mechanisms such as Bayesian updating.

Some scholars use the phrase *core knowledge* for domain-specific systems that drive young infants' expectations about domains such as physical objects and goal-directed agents ([Carey & Spelke, 1996](#); [Spelke & Kinzler, 2007](#)). Core knowledge is depicted as “resilient” and unlikely to change dramatically with development, which is a muted way of saying that core knowledge is innate. Parameters might be adjusted, but radical restructuring of central properties and relations is rare. Core knowledge areas are described as domain-specific products of evolution that may be potentially overridden by massive counterevidence, but, even then, core knowledge is prone to leak out under conditions of high cognitive load ([Shtulman, 2017](#)). Core knowledge approaches usually contrast core knowledge with intuitive theories, which are acquired through experience. Intuitive theories are seen as massively modifiable as long as they do not violate core knowledge foundations. Theories of all types, including intuitive ones, are therefore capable of complete reorganizations that can obliterate the earlier versions of the theory. If there are innate aspects to intuitive theories, they are inherited from core knowledge.

In contrast, a different perspective argues for intuitive theories as present “all the way down” to young infants. In these accounts, there are no principled differences between intuitive theories of young infants and sophisticated adults ([Gopnik, 2003, 2011](#); [Gopnik & Wellman, 1992](#)). Theories are revisable given the right set of experiences. These views have a more natural affinity with empiricist approaches by positing high malleability given appropriate inputs. However, *theory theory* proponents disavow empiricist labels because they require some sort of innate hierarchical and inferential cognitive machinery in the learning engine. Given that the machinery is domain general, it can still be broadly nativist in the sense that all empiricist approaches require innate domain-general learning systems.

A third view accommodates innate domain-specific constraints at all levels of processing. These can range from perceptual and cognitively impenetrable constraints to those that are purely cognitive ([Keil, 1981](#); [Laurence & Margolis, 2024](#); [Margolis & Laurence, 2023](#)). In these accounts, a priori domain-specific biases can occur at any level of abstraction not just at the level of core knowledge. One manifestation of higher-level constraints might be domain-specific biases toward particular causal path structures. For example, common cause and common effect networks might be emphasized differently in broad domains such as intentional agents and physical objects ([Strickland et al., 2017](#)). Such constraints do not preordain specific concepts; instead, they result in strong biases for certain types of causal and relational patterns in a domain covered by an intuitive theory.

Are intuitive theories located in individual minds?

Several researchers have emphasized ways in which cognitive work can be distributed across individuals ([Hutchins, 2020](#); [Smaldino & Richerson, 2013](#)). This reliance is less obvious in young infants but is clearly present within a year or two. From toddlerhood on, we all rely on knowledge in other minds, often mistakenly believing we know or have learned theories as isolated agents when, in fact, we have offloaded learning and beliefs to other minds and, more recently, to search engines ([Henrich & Muthukrishna, 2023](#); [Hutchins, 1995](#); [Sloman & Fernbach, 2017](#)).

Are intuitive theories partially embedded in the external world?

In addition to being distributed among minds, we also offload intuitive theories to environmental placeholders and reminders without realizing it. We may think we know exactly how a stapler works and illustrate our competence by explaining how every part of stapler works with a stapler in front of us. However, when there is no stapler present and people must reveal their understanding of staplers from memory, they will almost always omit critical mechanical components. Intuitive theories achieve cognitive economy by relying on objects to fill in gaps, but we often fail to realize just how much we rely on such external “memory” stores.

What does it mean to have an intuitive theory?

Cases where intuitive theories are shared across minds or are highly incomplete without the phenomenon available for inspection raise the more general question of what it means to “have” an intuitive theory. Does it need to be self-contained in one mind to count as a true intuitive theory or is it sufficient to be able to construct a full theory in the moment when appropriate resources, both human and artifact, are available?

Broader connections

Intuitive theories as nomological versus narrative explanations

Intuitive theories in cognitive science tend to be depicted as sets of principles, laws, or rules. Such formats easily generalize to a wide range of cases. Yet, a different form of “theory” may occur in narrative formats, often resting on individual case histories that are then used as exemplars supporting similarity-based reasoning. Narratives are especially common when attempting to make sense of the actions of intelligent agents. A person’s intuitive theory of parenting may be based on a richly articulated narrative of their own parents and how that story unfolded over time. It might also include narratives of parenting in other families that contrast sharply with their own experiences. A cluster of such narratives could then serve as exemplars that are used to interpret and predict the behaviors of parents in general [see [Parenting](#)]. Should such a cluster of parenting narratives be considered an intuitive theory? Interest in narratives has not been consistently strong in the cognitive science, but as researchers more clearly see them employed in situations involving human agents and indeterminate probabilities, their relations to intuitive theories become a topic of interest (e.g., [Johnson et al., 2023](#)).

Variability of intuitive theories across individuals and groups and over time

Intuitive theories can vary with experience and development, sometimes undergoing dramatic metamorphoses. But other forms of intuitive theory variation have rarely been studied in a systematic manner. Can we predict how intuitive theories will vary in both individuals and groups across different situations? Intuitive theories of diseases, for example, seem to show considerable variation across cultures and often within culture as well. Within North American cultures, beliefs about the causal underpinnings of diseases and their cures can differ within adjacent communities. Thus, registered nurses and college undergraduates tend to avoid interactions between psychological and biological processes in their explanations of diseases, whereas energy healers invoked rich interactions across domains ([Lynch & Medin, 2006](#)).

The relationship between variability and context is complex and raises several important questions. What sorts of situations drive group members toward consensus as opposed to diverse opinions? How does the range of intuitive theories about the same phenomena within an individual mind compare to the range across individuals in a community? In what situations do intuitive theories vary but still share a common set of critical properties distinctive to a domain? How does intuitive theory variation across developmental change relate to intuitive theory variation across historical change?

Intuitive theories as providers of predictions and explanations

Intuitive theories are thought to provide explanations about why entities in their domain have certain properties and how those properties matter. They often posit nonobvious causal relations that tie elements together in a coherent way. They also provide frameworks for making novel predictions. But the historical linkage between explanation and prediction may be shrinking. As various machine learning programs acquire larger data sets and refine their computations, they may provide more accurate predictions at the cost of diminished explanation. A deep learning program that invokes hundreds of thousands of hidden variables and their interactions can become a black box whose operations are unexplainable by humans. Given past problems with incorrect theories, these advances in machine learning have inspired calls to focus primarily on predictions (e.g., [Yarkoni & Westfall, 2017](#)). Is there a set of intuitive theories that we use to make predictions but do not provide usable explanatory insights for, or is explanation more intrinsic to intuitive theories? How might these contrast with narrative explanations that do not make predictions?

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