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Feature Review

# Towards a Cognitive Science of the Human: Cross-Cultural Approaches and Their Urgency

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**While a major aim of cognitive science is to understand human cognition, our conclusions are based on unrepresentative samples of the world's population. A new wave of cross-cultural cognitive science has sought to remedy this with studies that are increasing in scope, scale, and visibility. Here, I review the state of this new wave of research. The portrait of human cognition that emerges is one of variations on a theme, with species-typical capacities shaped by culture and individual experience. The new wave has expanded our understanding of processes underlying human variation and cumulative cultural change, including mechanisms of social learning and cultural transmission. Less consensus has been reached, however, on the cognitive foundations of human nature. The promise of cross-cultural cognitive science will not be fully realized unless we continue to be more inclusive of the world's populations and strive for a more complete cognitive portrait of our species.**

## Highlights

Cognitive science faces a representativeness problem, with most research occurring in educated, industrialized populations.

A review of 10 years of cross-cultural research shows progress in remedying this, but research is still bimodally distributed between educated city dwellers and small rural populations.

The decade has seen progress in understanding individual cognition (e.g., perception, reasoning), interpersonal cognition (theory of mind, personality), and societal cognition (social learning, norms, cooperation, morality).

Formal models of social learning and cultural evolution are improving our understanding of the mechanisms underlying human variation and similarity, but we remain far from a satisfying account of human nature and human cognitive universals.

Without a more inclusive cognitive science, our portrait of human cognition will remain incomplete.

## The Promise of Cognitive Science

The aim of cognitive science is broad: to understand cognition, in all its forms. It was born as a union of fields, including psychology, philosophy, linguistics, neuroscience, computer science, and anthropology. While some areas of cognitive science do not concern human cognition, it seems safe to say that what interests the majority of cognitive scientists is us. We seek to understand the nature of our thinking, what is universal and variable about it, and how human cognitive mechanisms respond to and are shaped by the diversity of circumstances that we experience.

How are we doing? A recent survey of the field suggests that of the six fields comprising cognitive science, it is heavily dominated by psychology [1]. In principle that is not bad, because psychology, like cognitive science more generally, seeks to understand the nature of human thought. However, as frequently pointed out by anthropologists and sometimes psychologists themselves, the field of psychology is heavily skewed towards research with particular kinds of subjects (mostly, college students) and methods, including laboratory-based experiments, that orient us towards certain kinds of phenomena and ways of measuring them [2,3]. To the extent that the aim of cognitive science is a portrait of human cognition writ large, then drawing conclusions about a small and unusual slice of humanity by bringing them into the laboratory to look at computer screens will not do [4]. At the very least it will result in a portrait of human cognition that is incomplete and quite possibly biased as well.

This argument was made forcefully by Henrich, Heine, and Norenzayan in a 2010 paper entitled 'The Weirdest People in the World?' [5]. This paper introduced the now-popular acronym 'WEIRD' (Western, educated, industrialized, rich, democratic) to describe the typical research subjects of behavioral science, with the added nuance that these research participants might indeed be 'weird' compared with most humans around the world and over human history. Each of the factors captured by the acronym WEIRD also has the potential to shape cognition in ways that might radically bias conclusions we draw about human cognition. For example, education, literacy, and exposure to electronic media may deeply influence the development of

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cognitive abilities and even brain structure [6], yet the vast majority of cognitive science research is done on just this literate population.

Most cognitive scientists agree with this point. The 'WEIRD problem' has become widely known and has spurred researchers to action, spawning what might be called a 'new wave' of cross-cultural cognitive science (CCCS) research. Here I will review this new wave of post-WEIRD research, with three goals in mind. First, I will summarize and describe the state of the field since 2010, using a systematic literature search to identify and highlight significant trends in the field. Second, I will attempt to summarize what this new wave of research has told us about human nature: human cognitive universals, human cognitive diversity, and what sets us apart from other species. Third, I will examine where the new wave continues to fall short of our aspiration to create an accurate and representative cognitive science of the human.

## A Brief Sketch of the Problem

There can no longer be any doubt that cognitive science and its most prominent subdiscipline, psychology, face a representativeness problem in the use of research participants. Since the WEIRD paper, a variety of papers have appeared examining this problem and its consequences in greater detail [1,4,7–11]. To take one example, a survey of top developmental psychology journals from 2006 to 2010 found that over 90% of research participants were WEIRD, with around 60% from the USA, another 15% non-US English speakers, and 15% from Europe [10].

Another problem, less often addressed, is the nonrepresentativeness of the researchers themselves. Most researchers in cognitive science are from a skewed subset of the world's countries, reflecting a bias in science in general, in which the majority of publications come from the USA and Europe [12]. An important question concerns the degree to which our theories, methods, and research questions are biased by our own cultural backgrounds, a phenomenon with which anthropologists have been particularly concerned [13]. Beyond regional bias, the strong disciplinary bias towards psychology within cognitive science documented by Núñez *et al*. [1] potentially means that certain topics and perspectives may be heavily over-represented or under-represented in the field. Anthropological perspectives on human nature and human diversity, for example, are nearly absent.

Why should these factors matter for cognitive science? The general answer should be obvious: unrepresentative sampling leads to faulty conclusions. What might be less obvious, however, is exactly how these aspects of nonrepresentativeness might influence our conclusions. As of yet, we do not fully understand how the factors associated with WEIRD societies shape human cognition, but there seems no doubt that some cultural ideas, practices, values, and traditions have, for a variety of historical and economic reasons, spread globally at the expense of others. The ideologies of colonialism, capitalism, neoliberalism, and world religions have had a profound impact on social and economic life, and likely on cognition as well, as they edge out less expansionist cultural traditions [14]. Technological change, too, has multiple influences on how we think, through changing our daily activities and the structure of social interaction. Of course, the WEIRD acronym is too simplistic to capture all of these factors and processes, but there is a growing concern among cognitive scientists that by relying on the convenience samples that we typically study (e.g., college students, mTurkers) we are systematically biasing our conclusions, mistaking WEIRD cognition for human cognition writ large.

How big of a problem is this for cognitive science? Sometimes psychologists and neuroscientists argue that cultural variation is not likely to impact fundamental aspects of brain structure, or 'core' cognitive processes (e.g., perception, memory, attention). This could be true, especially if one defines a 'fundamental' or 'core' process as 'one that is not influenced by cultural variation'. Some

would prefer to dodge this question by abandoning the very idea of fundamental or universal cognitive processes. But surely there are species-typical human cognitive processes, even if they vary, as all biological traits do, and surely it is one goal of cognitive science to understand them. Here we are faced with a chicken-and-egg problem: in order to understand which cognitive processes vary and which do not, we need research across cultures, and in order to discover such variation or similarity we must decide which people and processes to examine. As I will argue in the following review, while CCCS has made admirable progress in understanding cognitive variation and the factors that shape it, we are still falling short of the field's promise as a science of human nature.

## The New Wave of CCCS

Here I will use the term 'new wave' to refer to CCCS since the 2010 WEIRD paper, with the following caveat. There is no evidence that this new wave represents a discontinuity or paradigm shift from prior work. Cross-cultural work in psychology and cognitive science has a long and robust history, stretching back to the beginning of the last century and beyond [15,16]. The 'new wave' simply refers to the last decade in this tradition. To the extent that the WEIRD paper was a call to arms, perhaps the new wave can be seen as taking inspiration from it, but this review later does not suggest anything like a sea change in how we do cross-cultural research. Still, the field has shown steady progress in its scope, methods, and questions, and a review of the last 10 years gives us a portrait of latest trends in the field.

I conducted a survey of the cross-cultural literature since 2010 using the Web of Science platform. Because of the diverse nature of this work, it is impossible to capture it with a single, algorithmic search, so I used a multistep process to try to extract a representative, though by no means exhaustive, portrait of research in the field. This search resulted in a sample of 249 papers reporting empirical cross-cultural studies since 2010 (details of the survey procedure, and a full list of papers, are available in the supplemental information online). Based on this search, I arranged the diversity of recent work into 15 categories in three major areas: individual cognition, interpersonal cognition, and societal cognition. These are shown in Figure 1. I also created a word cloud of the 200 most common words in the titles of these papers (editing out common redundant words like 'culture' and 'cross-cultural'), which gives another portrait of the common themes and variations in the new wave of CCCS, including the popularity of developmental work (Figure 2). Finally, I used the results of the survey to create a map of where around the globe CCCS research is occurring, with countries color-coded by number of studies in which they are sampled (Figure 3).

While this analysis shows that there is a reasonable degree of global representation in the new wave of CCCS, research is still unevenly distributed across the world's populations, focusing heavily on comparisons between the USA and China. Work in other places, particularly in the global south, is less common, though increasing. Promisingly, of the 217 studies used to create the map in Figure 3, over half (53%) included data from 'small-scale' societies (see the supplemental information online for details). There are hot spots of research in certain places, such as Vanuatu and Fiji, because of the high productivity of some research teams. However, the distribution of research participants is still skewed, with most participants coming from college student and online populations, and a smaller mode in small-scale societies, with a gap in research on populations between these two extremes.

Based on the results of the search, I sorted papers into 15 areas of research in the domains of individual cognition, interpersonal cognition, and societal cognition. These are gestalt categories that are not necessarily meant to reflect existing technical distinctions in the literature, but rather aim to capture the 'level' of the processes involved. Individual cognition refers to

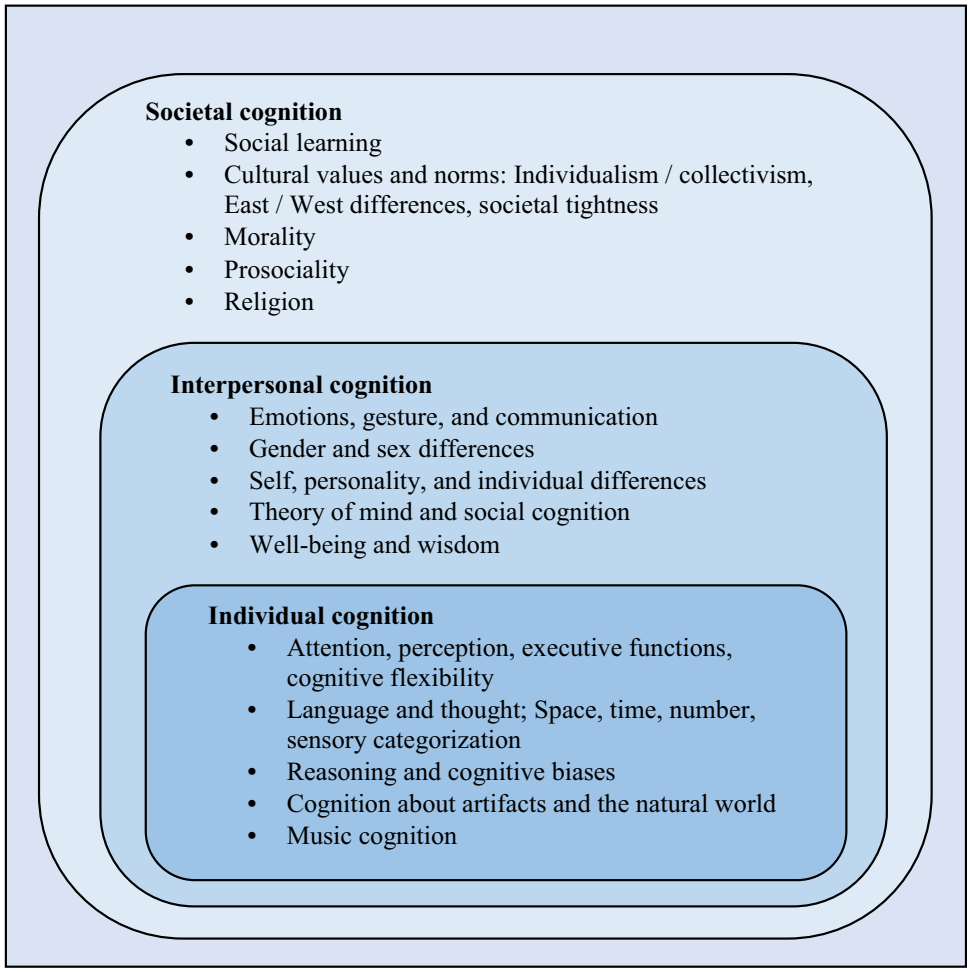
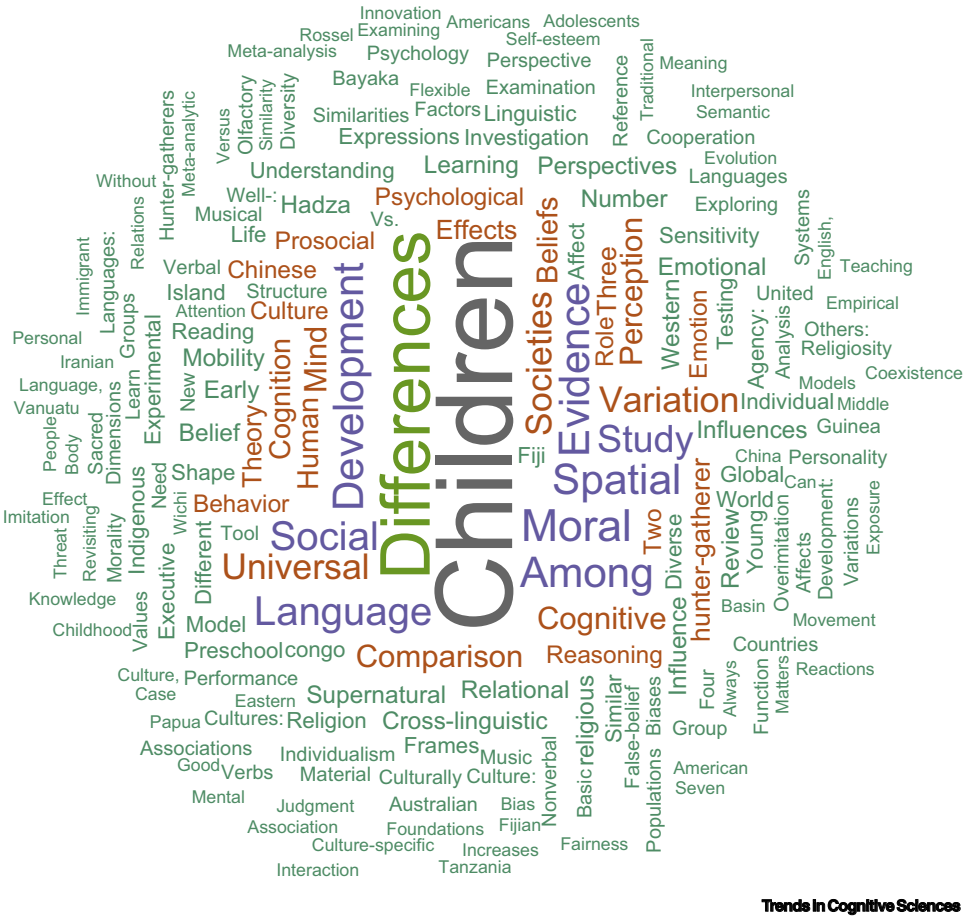



Figure 1. Areas of Research in the New Wave of Cross-Cultural Cognitive Science.

processes that mostly have to do with subjective cognition about the world and self: for example, perception, attention, reasoning, and executive functions. This does not imply that these processes are not socially or culturally shaped (indeed, that is what most of the CCCS work on these topics investigates) but rather that the target of the processes involved is personal knowledge or experience. Interpersonal cognition refers to processes that are principally about social interaction and that have as their target, typically, person-to-person dyadic interactions: for example, presentation of the self, emotions and communication, and theory of mind (ToM). Finally, societal cognition refers to processes that have as their target larger-scale social processes, such as morality, religion, and cultural values and worldviews. A strong caveat here is that none of these categories are mutually exclusive. Instead, they might be regarded as standing in a hierarchical relationship, where individual cognitive processes are embedded within and shaped by interpersonal ones, which in turn are embedded within societal processes (Figure 1).

## Individual Cognition

Work on individual cognition has formed the bread and butter of much of cognitive science, including work on perception, attention, reasoning, and language. Perhaps because these

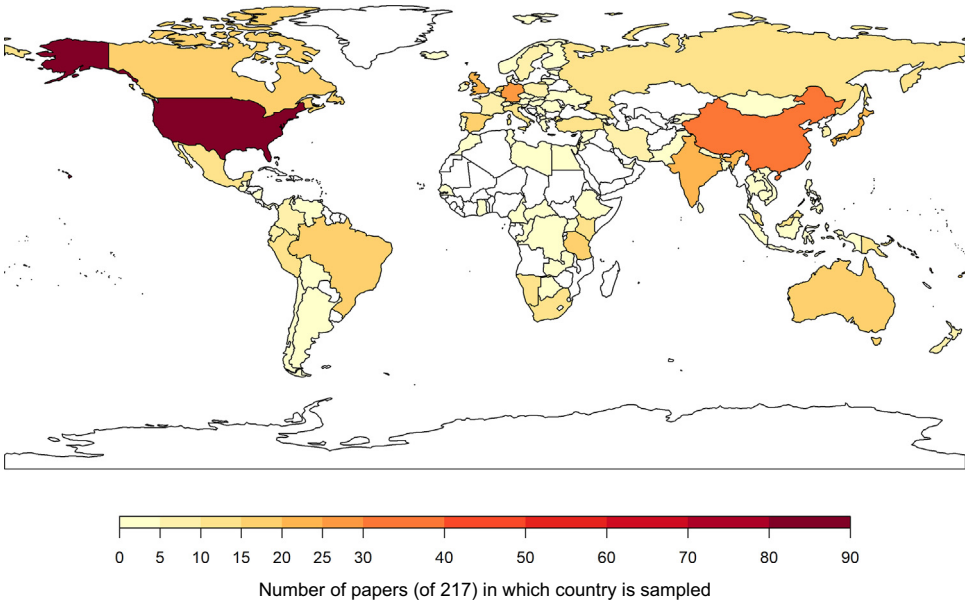



Trends in Cognitive Sciences

Figure 2. Title Words in Cross-Cultural Cognitive Science Papers, 2010–2020.

have long been considered to be among the most fundamental of cognitive processes, the search for possible cross-cultural variation in them traces back to the origins of psychology and anthropology [17]. The range of CCCS work on individual cognition is broad and includes work on musical cognition [18,19], biases in judgment and decision making [20,21], learning and reasoning about the natural world [22–24], and executive functioning and self-regulation [25–27]. Because individual cognitive processes such as perception, attention, and executive control are often taken to include universal, species-typical mechanisms, this is a particularly fruitful area for our efforts to understand what it means for a mechanism or process to be universal, or part of 'human nature'.

A major thread of CCCS research has sought to examine how aspects of personal experience, including our physical, social, and linguistic environments, shape individual cognition. A good example is work on number cognition [28–32]. Here there has been a long-standing debate about which aspects of our abilities to represent and make inferences about magnitudes and numerosity, in particular, counting, arithmetic, and other mathematical skills, arise from universal, evolved capacities and which come from culturally evolved technologies, including numerical representations in language. CCCS research has provided mounting evidence for the claim that counting, and in particular, the ability to represent exact integer quantities larger than two or three, is dependent on the presence




Trends in Cognitive Sciences

Figure 3. Distribution of Countries Represented in Cross-Cultural Cognitive Science Research.

of integer number terms in one's language [31,33]. What is universal, on this account, is an evolved ability to represent and compare magnitudes or amounts (a continuous dimension, as in the amount of water or sand) but not to represent or compute exact numbers [34].

In a tradition extending back to Sapir and Whorf, cognitive scientists have been interested in the causal interplay between language, cognition, and experience: for example, how linguistic representations of abstract concepts such as space and time influence spatial and temporal cognition [35–40]. A fascinating line of work examines how sensory qualities, especially in sensory domains other than vision, are represented in languages and how this influences experience and perception. References to vision and visual qualities predominate in the world's languages and fine-grained distinctions about visual properties such as color are typically easier to make than for other senses such as touch or smell [41,42]. Some languages, however, such as Semai, Jahai, Maniq, and Cha'palaa, have rich olfactory lexicons and their speakers are able to perceptually categorize smells in a much more fine-grained way than, for example, English speakers [43–46]. Ecology appears to play a role here too: Semaq Beri foragers were better at odor naming than Semelai horticulturalists who speak a closely related language, reflecting the importance of smell for foraging [47].

This work illustrates two concepts that are critical for a biologically sound understanding of human nature: plasticity and reaction norms. All traits vary, even species-typical traits such as our sense of smell. Some of this variation (but not all) is due to plasticity, or the ability of developmental systems to alter phenotypes in response to the environment [48]. A reaction norm describes how a trait in a given organism develops differently depending on environmental circumstances [49–51]. For example, people who forage daily develop fine-grained odor categorization skills that city-dwellers do not, a good example of biological potential that does not develop fully when not used. Different species have different reaction norms: dogs growing up across a range of olfactory and social environments exhibit one reaction norm for smell and humans another. Human universals might best be thought of as variations on a theme:

species-typical traits that exhibit reaction norms leading to variation in the trait. Olfaction, language, ToM, and moral judgment are all examples, explored in more detail later [51].

Armed with more sophisticated tools for theorizing mechanisms of similarity and variation, research from the new wave is providing increasing support for this view of human nature as variations on a species-typical theme. It is also improving our understanding of how the causes of cognitive variation in humans, including language and culturally transmitted information, differ from those seen in other species (Box 1).

### Interpersonal Cognition

Interpersonal cognition refers to processes that have as their target direct social interactions with others. Again, nearly all the processes studied by CCCS have an interpersonal quality to the degree that they are shaped by cultural processes, but for some the function of the process itself is interpersonal.

A good example of interpersonal processes are those involved in the construction and presentation of the 'self'. Here, what cognitive scientists mean is not the actual object or body that is the person, but rather, our representations of who we are and the thoughts and behaviors we manifest in the course of interacting with others and negotiating those interactions. This includes aspects of personality such as introversion and extroversion, which are defined interpersonally, as well as our judgments about other selves, such as attributions of agency or choice to others.

There is a long history of work on the self in CCCS, which includes work in cultural psychology on cultural differences in how the self is conceptualized, including variation in how unitary the self is seen to be across time and context, as well as work on 'East/West' differences in cognition that

#### Box 1. Mechanisms of Cultural Variation and Culture Change

A rich theoretical literature explores the mechanisms that lead to variation across individuals, cultures, and generations. Central is the concept of plasticity: the ability to adjust phenotypic traits to fit local conditions [48]. Individual and social learning are mechanisms of plasticity and can lead to variation across individuals and cultures. Because social learning is how information is transmitted from individual to individual, it is the cultural analog of biological inheritance and key to models of cultural evolution.

Contemporary models of cultural evolution treat individuals' cultural traits (ideas, beliefs, habits, cognition) as parts of their phenotypes, nested within populations of cultural learners and actors. Cultural evolution refers to change over time in these populations, which occurs in tandem with genetic, epigenetic, and environmental change [83,86,88].

Processes of cultural evolution exhibit some analogs to genetic evolution and some differences [162]. Much if not most cultural variation is probably random rather than systematic, the result of cultural drift. The cultural analog of natural selection occurs when some ideas, beliefs, or practices spread systematically at the expense of others. This depends both on how well the ideas themselves spread (cultural epidemiology) and the effects those ideas have on the survival and reproduction of the people that hold them (culture–gene coevolution) [163,164]. Traits influencing cultural transmission, such as learning biases, evolve because of their fitness effects on populations of learners. These include biases to acquire information because of its frequency (e.g., conformity bias), source (e.g., prestige bias), or content (e.g., negativity bias) [85,159,163]. Models investigate conditions under which particular biases are favored. Conformity bias, for example, is favored when the 'wisdom of the crowd' holds true [163].

Unlike the transmission of genetic variants, which tends to be unbiased, cultural transmission is often biased, resulting in distinct dynamics in the cultural domain. In addition to broad learning biases such as conformity, cultural epidemiologists refer to cultural attraction processes whereby some information is 'stickier', or better transmitted from mind to mind, than others. Complex psychological factors beyond simple biases may come into play, such as the fit of information with prior beliefs [89,139].

Finally, the environment can play a role in cultural evolution via our role in shaping it, known as niche construction [87]. Global warming, for example, is both caused by human cultural practices and likely to shape them in the future.

suggest that Westerners focus more on individual choice and agency and Easterners more on structural determinants of behavior [52,53]. Recent work has sought to delve more deeply into the causal, mechanistic explanations for cultural differences in this domain. One line of work has investigated how social life is shaped by ecological demands, such as agricultural practices, and how these percolate into different styles of self-presentation and judgment [54–57]. Others investigate more socio-historical explanations, such as the dissolution of kin marriage by the Catholic church [58].

Another thread of CCCS work on interpersonal cognition concerns how we make inferences about others' inner lives, including their thoughts, emotions, and motivations. This includes work on facial, vocal, and other expressions of emotion [59–64] and work on 'mindreading', or 'ToM', the ability to infer and react to others' mental states via their observable behavior [26,65–73]. Here again, cognition is organized as variations on a theme: emotion reading and mindreading develop in most neurotypical individuals, but there are cross-cultural differences in how the domain of emotions is parsed, linguistically, and how ToM is used in everyday cognition, including moral judgment (Box 2).

Other research on interpersonal cognition includes work on cross-cultural variation in the structure of gender [74,75] and personality [76–79]. While there is much work showing a 'big five' personality structure in WEIRD societies, a structure thought to be highly robust, this structure is not found universally [77,79]. Modeling work suggests that personality structure may facultatively respond to the availability of different personality 'niches' in a society [80,81]. If so, there is much more plasticity in this aspect of human psychology than WEIRD research had suggested.

### Societal Cognition

Societal cognition refers to aspects of cognition with targets or functions that concern social phenomena beyond the level of the interpersonal dyad. Moral cognition, for example, concerns not just how we comport ourselves or behave with our neighbors, but how we think about what is right and wrong in general. These are matters of cultural worldview, mores, and norms. Societal cognition is deployed in our dyadic interactions, of course, and has the potential to

#### Box 2. Theory of Mind: Universal, Variable, Human-Specific?

The ability sometimes known as 'Theory of Mind' (ToM) or 'mindreading', which refers to our sensitivity to others' mental states, has become one of the most widely studied processes of interpersonal cognition [150,165,166]. Work in this area is a paradigm case of the interdisciplinarity of cognitive science, drawing on philosophy, neuroscience, linguistics, anthropology, biology, and psychology, including developmental comparisons, cross-cultural comparisons, and cross-species comparisons. Still, there remains substantial debate about the nature of ToM, with some scholars arguing that it is a universal, evolved faculty of human cognition, and others that it is a culturally evolved ability installed in our minds via cultural transmission [149–151,167].

Much debate in this literature has focused on a highly specialized form of mindreading known as false belief tracking, originally proposed as a criterion for ToM because it requires representing another's internal belief state and not just observable cues [168]. Here, for a long time, the conclusion from comparative work was that this was an ability unique to humans, with development work showing it emerging around the age of 4 years, except in children with autism [166]. More recent research, however, has complicated this picture. Cross-cultural work with the standard false belief task has shown variability in the age window for 'passing' the task, suggesting a key role of culture and environment [67,69,70,73,169–171]. Recently, new techniques have provided evidence that chimpanzees can track false beliefs, breaking down a long-held division between humans and other species [172,173]. And finally, methodological innovations in infant work showed evidence for belief tracking as early as 1 year of age, using nonverbal tasks [174–176]. Recently, these tasks have been transported across cultures, showing a surprising degree of similarity in early, nonverbal false belief tracking [66].

A tentative conclusion to be drawn from this work is that humans possess a nonverbal ability to track others' beliefs that has a characteristic reaction norm, developing in early childhood but with variation across individuals. The basic mechanisms underlying this ability are likely to be homologous with those in closely related species such as chimpanzees, but it certainly takes human-specific forms. ToM likely plays a role in communicative pragmatics (i.e., understanding what someone intends to communicate) as well as in cooperation, moral judgment, and social learning [93,123,177,178]. Like other species-typical skills, it also shows variation across individuals and cultures.

shape all levels of cognition, as we have seen. But it is also, perhaps, a level of cognition that makes us unique as a species. While other animals certainly have both personal and interpersonal cognition, it is not clear that any have anything like group-level culture that varies from place to place and persists through history in quite the same way that humans do [51,82–84].

It is in the study of societal cognition where, arguably, the most progress is occurring in the new wave of CCCS research. This is in part because of a vibrant and growing area of theoretical work on mechanisms underlying cultural variation and cultural change, which have increasingly allowed the field to move beyond the mere cataloguing of cultural variation to explaining it. This theoretical toolkit includes work from evolutionary developmental biology and psychology on plasticity and reaction norms; culture-gene coevolution theory and its concepts of transmission biases and cultural group selection; niche construction theory and the notion of reciprocal cognition-environment feedback; and cultural epidemiology theory with its notion of cultural attractors [51,83,85–89] (Box 1).

A key component of models of cultural variation is social learning and for this reason I have included social learning under societal cognition. It is the vehicle through which we become acculturated. Social learning is itself a human universal, though it takes many forms, ranging from mere social influence to explicit teaching [90–94]. A general lesson of cross-cultural work is that we are outstanding social learners, much better than many other species, so much so that this has been dubbed 'the secret of our success' [82]. The form of cultural learning in which humans are specialized is a two-sided process: we are well adapted both to acquire and to transmit culture [92,95–98]. This is something that as humans we take for granted, but compared with even our closest primate relatives, human social learning is remarkable. Human children can and do easily learn in an untutored way [91]. Outside of formal schooling, children learn much from their peers, including older or more knowledgeable children [99–103]. And, unlike some other species, humans are not merely blind or equal-opportunity imitators, but rather, are good at homing in on the purposeful, intentional aspects of the behavior they are observing [102–104] (Box 3).

What social learning installs in us, of course, is culture; it is the vehicle of societal cognition. There has long been debate about how we should conceptualize this structuring of cognition by culture. Does it infuse its way into everything implicitly, so that we end up like fish in water, unaware of it? Or does it enter us as explicit rules and representations, like the Ten Commandments? CCCS research has investigated both.

On the implicit end, as mentioned earlier, there is a robust thread of research in the new wave that examines how societal structure and cultural values (including explicit ones) can shape aspects of implicit cognition, including perception and personality. For example, a study of 33 countries found that the degree of societal 'tightness', defined as having strong norms and low tolerance of 'deviant' behavior, correlated with a variety of subjective and intersubjective cognitive traits, including a higher degree of self-monitoring, risk avoidance, and a sense of reduced personal agency and increased situational constraint [105]. This work dovetails with other work in cultural psychology and CCCS that ties personal characteristics, such as individualist versus collectivist orientations, to longer-term ecological factors such as subsistence style [53,57,106].

The study of prosociality, including phenomena such as generosity, trust, and fairness, is another burgeoning area of research in the new wave of CCCS. Some aspects of prosociality are embodied unconsciously, in our personalities and self-expression, and others take the form of explicit beliefs about how we should treat others. An influential line of work has used varieties of economic games in which participants are placed in real-world decision-making situations in which they must divide

### Box 3. The Varieties of Social Learning

There are many kinds of social learning and nearly as many taxonomies of it (for reviews see [94,96,97,179,180]). Perhaps the simplest form of social learning is social influence or contagion, as seen in crowd behavior. In enhancement, a learner's attention is drawn socially to a place or object, leading to altered individual learning about it [94]. Both of these are seen in non-human animals.

Some social learning can be described as copying. The preferences of others can be copied, as in mate choice copying [181]. Imitation refers to copying the specific form of another's actions. Emulation occurs when the learner attempts to reproduce the goals or end-state of the source's actions. Emulation is thought to be more cognitively demanding than imitation, involving inference of goals and means-ends relationships. A debate has surrounded the degree to which these forms of social learning occur in other species, though it is clear that social learning is phylogenetically widespread [93].

Social learning occurs through various modes, including exploration, observation, participation, imitation, and instruction [96]. Exploration, observation, and participation are common modes of social learning around the world, with multichild playgroups a common form of transmission of social norms and subsistence practices [101,182]. The cross-cultural prevalence of instruction has been more controversial [91,92]. Recent ethnographic reviews suggest that it too is likely universal, especially apprenticeship-like teaching of skills [101,183].

Debate surrounds which kinds of social learning might be human-specific. Csibra and Gergely have proposed a human-specific form of teaching known as natural pedagogy that involves special demonstrations of instrumental actions to infants ('look!'), who learn via a form of emulation or goal-based learning [98]. A possibly distinctive mark of human social learning is overimitation, in which learners copy seemingly purposeful aspects of a procedure even if they are known to be functionally unnecessary. Even here, however, there is cultural variation [102,103,184].

While tool use is sometimes thought to be the evolutionary source domain of social learning, much or perhaps most human social learning is not specifically about how to use things. Learning of language, social norms, and rituals are all examples [97]. Moreover, much social learning might be better seen as 'reconstruction' rather than 'copying' [89]. A question for future work is how the broadening of our social learning abilities to new domains and information types has contributed to our success as a species [82].

money between themselves and other players. This work has demonstrated two primary features of human prosociality: first, humans everywhere tend to be more generous than would be predicted from simple self-interest alone, defined in terms of money maximization; and second, there is substantial cultural variation in typical behavior in these games, governed by cultural norms about generosity and trust towards particular categories of individual [107–109]. As measured by these methods, humans everywhere are far more prosocial than other species, but this prosociality is flexible and socially shaped.

The new wave has seen a growing number of studies of prosociality in children and how it develops across cultures. One branch of this work examines children's sense of fairness, defined as aversion to unequal distributions of resources [110–113]. Cross-cultural comparisons using standardized games suggest that disadvantageous inequity aversion (aversion to others getting more than you) develops reliably by middle childhood, whereas the more prosocial variety of inequity aversion develops later and is more culturally variable [112]. Consistent with this is work using simplified dictator games that shows that children tend to make self-oriented decisions until middle childhood (i.e., around 8–10 years), when their decisions become more prosocial, beginning to resemble those of adults in their cultures playing the same games [114]. Experimental evidence suggest that middle childhood is a period when children begin to follow the locally specific cooperative norms of their culture [115,116]. This suggests a possibly universal developmental mechanism of norm acquisition with a sensitive window in late childhood, which leads to diversity in prosocial behavior in adulthood.

At the most explicit level of societal cognition is our thinking about morality, ethics, spirituality, and other cultural values. While these topics have long been studied in anthropology and philosophy, the new wave has increasingly used cross-culturally transportable methods of cognitive science

to address them. One line of work has looked at the role that religions with 'big gods' play in structuring interpersonal behavior by providing a sense of being watched and a threat of supernatural punishment [117]. This hypothesis is supported by cross-cultural work showing correlations between belief in big gods and generosity in economic games, as well as other aspects of moral judgment [118–121].

The new wave has also seen a growing body of work in experimental philosophy, examining, for example, cultural variation in the degree to which peoples' moral judgments focus on intentions versus outcomes, the deontological/consequentialist distinction, attitudes about punishment, and attitudes towards various moral values (e.g., obeying authority, avoiding harm, maintaining purity) [122–132]. Morality is a difficult domain to study because of its complexity, but the new wave is beginning to reveal both universals and variation in moral judgment. For example, while some WEIRD psychologists have claimed that moral judgments are ultimately judgments about others' inner traits (e.g., their intentions, motivations, or character) CCCS work suggests this might not be a feature of all moral judgment [123,129] (Box 4).

Work in this area has the potential to address matters of pressing global importance. Sheikh, Atran and colleagues have used a mix of ethnographic and experimental methods with believers of various faiths to examine why people are willing to kill and die for a cause [133,134]. Other work examines the question of what moral rules or principles should be engineered into machines, how people might agree or disagree on what those rules should be, and if it is even possible for machines to be ethical [135,136]. Moral judgment itself appears to be a species-typical trait that is not present, at least in the same way, in other species, and yet what is considered right and wrong seems to vary dramatically across people and cultures. Understanding the reaction norms that build human moral judgment is a major challenge for cognitive science going forward, but one that holds promise for understanding, and perhaps alleviating, human conflict.

### Box 4. How Mind-Minded Is Morality?

A tradition in Western philosophy holds that one's mental and personal states (intentions, desires, motivations, and character) are central to our moral virtue. Many studies in contemporary psychology, neuroscience, and experimental philosophy conducted in WEIRD societies support this view [185–188]. Accidental harm, for example, is generally viewed as less morally wrong than intentional harm [189,190]. This is supported by fMRI studies showing that brain regions associated with mental state inference are active in processing moral judgment scenarios [191,192]. While the role of intentions varies across moral domains, such as purity (e.g., eating a proscribed food), an actor's state of mind appears fundamental to many kinds of moral judgment about them in WEIRD societies. This is reflected, for example, in the first-degree/second-degree murder distinction and in the saying 'it's the thought that counts'.

Such claims appear to stand in contrast to anthropological reports of societies where moral judgment and punishment explicitly disregard an individual's mental states [193]. In witchcraft, for example, it is frequently held that witches do not know they are witches, but cause harm nevertheless and are deserving of punishment. And some societies appear to link moral judgment and punishment solely to outcomes, judging intentional and accidental harms equally harshly, a phenomenon known in law as strict liability [194].

Against this backdrop, a growing body of work in the new wave of CCCS seeks to examine how moral judgments vary across societies and contexts. A study of moral judgment in ten societies found substantial variation in when and how people judged intentional wrongdoing to be worse than accidents, with some societies oriented much more towards the outcome of the act [123]. Follow-up studies have begun to examine possible reasons for this pattern. Is it rooted, for example, in beliefs about whether or not one can know another's intentions, or in cultural rules that assign blame based on the actor's social position [129,193]?

Even in WEIRD societies there are active debates about the degree to which someone's intentions should matter for blame: for example, in the case of discriminatory speech [195]. Here, CCCS work may prove vital for adjudicating these issues in legal and public spheres and help us to understand why people who agree on the facts of a case may still disagree about what is right.

## Lessons from the New Wave

What have we learned from the past decade of cross-cultural work? It has reinforced and expanded some things we already knew, added some new discoveries and, perhaps most importantly, underlined even more strongly how much there is still to know.

The main picture of ourselves that emerges from this work is not new. We are a deeply social and cultural species, more so than any other yet known. Some frame this as 'culture-dependence' (glass half empty) and others as 'culture wielding' (glass half full): these are both right. We need culture and cultural learning to survive, but it has also enabled us to expand, as a species, unlike any other on earth, so much so, in fact, that it could become our undoing [82,137].

What is new, in the past decade, is an increasingly sophisticated understanding of the mechanisms that lead to cultural variation and cultural change (Box 1). An emerging evolutionary synthesis views cognition as the product of interacting processes at many scales of space and time, with individual development, social interaction, cultural history, and genetic evolution all occurring simultaneously within a complex dynamical system [88]. Dynamics unique to the domain of culture, such as conformity, produce phenomena not seen in genetic evolution. In the phenomenon known as cultural group selection, cultural systems can spread as a unit: the stability and spread of world religions is an example [138]. We have also begun to understand how the dynamics of information flow depend on properties of individual psychology, including the psychological 'stickiness' of some ideas, a phenomenon known as cultural attraction [89,139]. This can explain phenomena such as informational 'virality', and the resistance of some ideas, such as supernatural beliefs, to change [140,141]. Together, these concepts are giving us new mechanistic understandings of age-old questions like 'why do people believe strange things?' The answer is not purely individual psychology, or 'irrationality,' nor is it purely social contagion. Rather, people can and do believe strange things for (evolutionarily) functional reasons, such as reliance on the wisdom of the crowd [142].

Similarly, our picture of the mechanisms of cultural transmission has evolved from an older view based on mechanisms like reinforcement learning and imitation to more sophisticated models of cultural learning mechanisms as evaluative. These include Bayesian models of cultural learning [143] and the notion of epistemic vigilance, in which learners weigh factors like source and plausibility [144]. We are getting a better picture of the mechanisms underlying 'cumulative' or 'ratcheting' cultural change, in which cultural systems can increase in complexity indefinitely, a phenomenon not seen in any other species [84,96,145]. The sophistication of human representational and symbolic systems certainly plays a role in this, but so too does distributed cognition and the unique forms of cultural niche construction in which we engage, such as the creation of writing systems, computers, and other forms of externalizing cultural information [146,147].

Still, there is much left to learn. Perhaps most striking is the continued lack of consensus among cognitive scientists on questions of human cognitive universals and 'human nature'. Semantic games and misunderstandings have certainly played a large role here, but few people would argue that the question of what humans share, cognitively, is meaningless. Physicians, neuroscientists, and psychologists would hang up their laboratory coats if it were impossible to generalize at least some findings from one person to another. Still, unlike the emerging consensus regarding mechanisms of cultural evolution and variation, proposals regarding human universals are invariably controversial.

At issue here, to some degree, are questions of mechanism. There is at least some agreement that certain phenomena are universal and/or uniquely human: examples reviewed earlier include

language, ToM, social learning, and morality. But look beneath the hood of any of these phenomena and you will see massive disagreement about what cognitive universals, if any, underlie any of them. Language is the classic battleground for this and continues to be so [148]. Even for a narrower and empirically well-studied ability, such as ToM, opinions run the gamut from species-typical, early developing, evolved adaptation to culturally installed 'gadget' [66,149–151] (Box 2).

The persistent negativity surrounding claims of human universals, and the failure to treat them in a biologically plausible way as species-typical traits with developmental reaction norms, has left us decades behind where we could have been had we fully embraced the idea of a cognitive science of the human [51,152,153].

## Challenges for the Next Wave

Our challenges going forward are both theoretical and methodological and these are intertwined. Some methodological challenges are old and much grappled-with, such as the challenge of cross-cultural validity of instruments and measurement (Box 5). So too are some theoretical challenges, such as the challenge of defining and identifying universals [152,154]. Other challenges, such as the WEIRD challenge, are newer, in cognitive science at least.

Against this backdrop and in light of progress made by the new wave, here are four goals I suggest we strive for in coming generations of CCCS research.

### Better Explanations of Variation

Models of cultural variation and culture change have been a major area of innovation in the new wave. Despite this progress, however, or perhaps because of it, there remains a large gap between the theoretical sophistication of models and the sometimes far simpler explanations

#### Box 5. Methodological Challenges for Cross-Cultural Research

Some of the biggest challenges for cross-cultural work are methodological. At heart is the problem of validity, or drawing valid conclusions from our data. As psychologists have long known, just because you ask a question and someone answers it does not mean they are telling you what you want to know.

Validity problems arise from two related sources: problems of measurement and the theory-measurement link. To draw valid conclusions you need to measure the right thing and it needs to be related in the right way to your theory. Cross-cultural comparisons present a special challenge because of the problem of comparability, or equivalence, of measurements across groups.

Cross-cultural researchers have compiled thorough taxonomies of biases and pitfalls that threaten comparability [15,155,196,197]. Construct biases occur when the construct measured is not the same across groups ('intelligence' is a notorious example). Method biases occur when methods lead to a construct being measured differently across sampled groups, due to confounding differences across the groups (e.g., literacy), differences in study administration, or differences in familiarity or comprehension of materials, such as Likert scales [155]. Sometimes items mean different things to people in different places (item biases), even if translated properly [197]. For example, the question 'how conservative are you?' does not mean the same thing everywhere.

These problems can be ameliorated with various strategies, like translation and back-translation, removing culturally laden items and concepts, and collaborating with researchers who have deep experience with, or are from, the cultural group being studied [198]. Additionally, greater attention to proper sample selection, recruiting participants along dimensions most relevant to the comparison being made, can greatly improve the validity of conclusions we draw.

Perhaps most challenging is the theory-measurement link. What does it mean to measure the 'same thing' in different places? In the moral domain, for example, the question of what it means for a moral situation to be 'equivalent' to different people is a deep one. If participants in two societies differ in how much they use an actor's intentions to assign moral blame in a vignette study, is that because of different norms for weighing intentions, or because the situation has different meanings in the two places? [123]. Here the cogency of our theories is crucial and is one reason why cognitive science cannot do without mechanistic accounts of cognitive universals and variation.

for cultural variation in the literature. Work reviewed earlier on kinship structure, market integration, societal tightness, and collectivism versus individualism is admirable for its rigor and search for major drivers of societal variation [57,58,105,108]. At the same time, however, a selling pitch for the newest evolutionary models is precisely that they allow us to go beyond single factors as the cause of variation and to consider complex interactions between individual psychology, population dynamics, and trans-generational processes. Future work should go beyond looking for 'main effects', or even simple regression-style interactions, to fit models of cultural dynamics to cultural data. While this is challenging, this review earlier suggests that we are poised to do it.

### More Principled Sampling of People and Phenomena

Part of achieving better explanations of human variation involves harnessing the power of cross-cultural comparisons to explore cognitive variation and similarity. An impression that emerges from the literature review earlier is that while cognitive scientists are actively striving to expand the diversity of their research samples, the choice of samples is often less systematic than it could be. For example, while some studies in 'small-scale' societies provide principled reasons for studying just those societies, others seem to treat them as a different kind of convenience sample: an antidote to WEIRDness, without further consideration of the historical and cultural particulars of those societies. There is a large middle ground between cosmopolitan urbanites and subsistence level villagers that remains largely neglected.

There are at least two strategies that could be followed more rigorously here: hypothesis-driven sampling and representative sampling. When *a priori* hypotheses for explaining variation or similarity exist, then populations should be selected purposefully to examine that variation, similarly to designing conditions in an experiment [152]. Studies that aim to discover sources and causes of variation *post hoc* may do better to sample representatively rather than sampling outliers or extremes, such as comparisons of college students with hunter gatherers. Finally, there needs to be a better fit between populations, questions, and methods: too often off-the-shelf measures are imported into cross-cultural studies as a matter of convenience [155].

### Renewed Attention to the Question of Species-Typical Cognitive Mechanisms

This is a promise of CCCS that has largely become lost in the quest to discover cognitive variation. Neuroscientists have not lost it and there has been impressive progress in using brain data systematically to discover fundamental structures and processes of cognition [156,157]. However, cross-pollination between this work and CCCS has been thin. To some degree this reflects a dismissive attitude by neuroscientists towards work outside the laboratory. But many cross-cultural researchers are equally dismissive of questions about universals. We are now poised to begin to remedy this gap, both theoretically and empirically.

Theoretically, notions of universals based on questionable concepts like 'innateness' are ready to be replaced by biological models centered on plasticity and reaction norms. Such models view traits as distributions rather than absolutes, but still enable us to study species-typical traits, including psychological and behavioral ones [49,51]. Empirically, CCCS can take a page from the 'phenomics' approach of neuroscience, in which cognitive processes are treated precisely as aspects of the phenotype and modeled using large datasets with sophisticated statistical model comparison [156,158]. CCCS is well-situated to provide crucial data for formal models of the structure of human cognition, if we choose to do so.

### Expanding Cognitive Science out of the Ivory Tower

Finally, while CCCS research has been broad in scope, it has tended to focus on questions that are more of academic than real-world interest. As academics this is understandable. However, CCCS limits its relevance and under-harnesses its extraordinary empirical power by not tackling

the cognitive side of phenomena such as inequality, poverty, political and religious extremism, the misinformation explosion, and global warming. As reviewed earlier, there is some work in these areas, as in the cognitive science of radical religious commitment, and the study of how false ideas spread [133,141,142,159]. But there is much room for improvement here. Global phenomena such as the persistent increase in global inequality and the rise of right-wing nationalist movements clearly reflect the interplay of cultural factors with ordinary human cognition, in ways that cry out for better mechanistic understanding. To the extent that runaway cultural and technological evolution, spurred by human drives and motivations, have contributed to worldwide environmental and economic precarity, CCCS potentially has something to say [137,147]. Here lies a major promise of understanding the complex feedback loops in which human nature plays a role [160].

## Concluding Remarks

Some cross-cultural cognitive scientists argue that there is urgency in this work, because of the loss of cultural and cognitive diversity in the face of globalization. While this is a powerful argument, it is not the only one. Culture loss is not a foregone conclusion and it is important not to treat human beings like endangered butterflies, to be photographed before going extinct. The persistent illusion that some societies are outside the influence of history is one that anthropologists have vigorously debunked, along with carving cultures into neatly delineated boxes [161]. No person or cultural tradition is more special, authentic, or characteristic of humankind than any other.

That said, it is undeniable that every one of us is an individual, idiosyncratic manifestation of human nature. And there is also no denying that history is a process of change and the historical clock can never be turned back. This moment on earth may be no more or less remarkable than any other, but there is no doubt that the specific manifestations of cognitive diversity that exist now will not last forever.

The urgency of CCCS flows from all the reasons that it is urgent to understand ourselves, as a species. Scientifically, this understanding cannot be complete without including the rest of humanity that is left out of this work; the map in Figure 3 provides a stark reminder of this (see Outstanding Questions). And from a practical point of view, many matters of pressing global concern hinge on human cognition, from our political and moral disagreements to the collective choices that determine the trajectories we are now following, politically, economically, and environmentally. For all of these reasons, a cognitive science of the human is more urgent now than ever.

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### Supplemental Information

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## Outstanding Questions

Which dimensions of cultural variation matter for human cognition, beyond the five implied by the WEIRD acronym?

Can binary distinctions such as Western versus non-Western, small versus large-scale, and collectivist versus individualist be replaced with concepts that better capture the multifaceted nature of human variation?

How can we move past correlations between cognitive traits and socio-environmental variables, like language and ecology, to demonstrate causal mechanisms of variation?

What kinds of data formats and sharing protocols can be used to build a cumulative, shared knowledge base of cross-cultural data?

How can we improve consilience between neuroscience and cross-cultural work, creating methods and data that can be transported between them?

How can we better document individual and cultural differences in brain structure and function, given the uneven geographical distribution of brain mapping technologies?

What aspects of cognition are produced by species-typical, evolved adaptations?

What aspects of cognition that we take to be part of human nature are in fact cultural particulars?

Via what mechanisms do individual differences in experience, such as growing up as a forager or speaking a particular language, give rise to cognitive differences?

How deeply do explicitly held cultural values, such as religious beliefs, shape implicit cognition?

How does individual level cognition scale up to macro-level processes such as the spread of ideologies?

How can we adjudicate the conflicts that may arise from variation in cognitive traits, such as moral preferences?

Can a better understanding of cognitive universals and variation be harnessed to

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counteract destructive global trends such as rising inequality and runaway environmental change?

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